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10 Consumer expectations and their role in food acceptance

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10.1 Introduction

10.1.1 Food acceptance: definition and measurement

The study of the human response to food is a complex and rapidly evolving field. It encompasses a wide range of scientific disciplines, ranging from food science and technology to nutrition, biochemistry, physiology, psychology, marketing and catering. As may be expected in such an interdisciplinary area, numerous scientific concepts have evolved to describe various aspects of the phenomenon under investigation. However, the terminology used to describe these concepts, as well as the methods for measuring them, differ from one discipline to another. Food 'acceptance' is one such concept. Since the focus of this chapter concerns factors that influence food acceptance, I would first like to describe and define food acceptance and then to detail the operational approach that we have used to measure it in the laboratory.

Figure 10.1 is a schematic model of human food-related behavior. At its most basic level, 'food' can be considered as a sensory stimulus, the physicochemical characteristics of which are determined by a variety of ingredient, processing and storage variables. The study of these variables and their effects on food falls within the domain of food science and technology. When an individual encounters food, its physicochemical characteristics interact with the human senses to produce experiences of its appearance, taste, smell, texture, etc. The theoretical and empirical study of the transformation of physicochemical energy into these basic human sensations defines the area of psychology known as 'psychophysics'. In applied areas of food science it is termed 'sensory evaluation'. At the next level of information processing, these basic sensory attributes are integrated with other biobehavioral and cognitive information. The sources of this higher-order information may include bodily states (hunger, thirst), learning and memory, psycho-social and cultural influences, and a variety of cognitive variables. Although each of these factors has been demonstrated to have significant effects on perception, psychophysicists and sensory scientists have not routinely addressed their

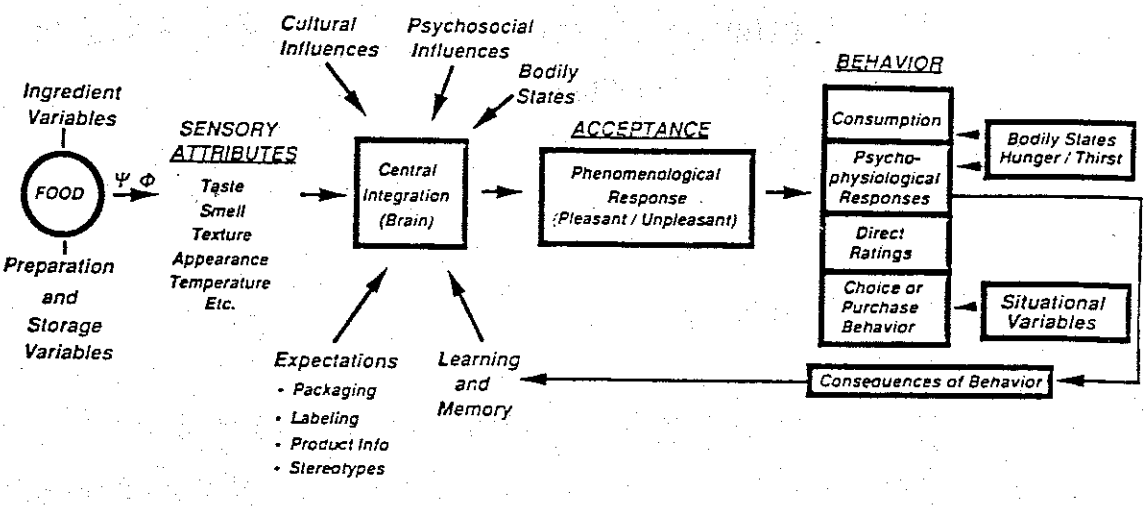


Figure 10.1 Schematic model of food-related behaviors.

effects. Rather, they have sought to minimize them through tight experimental controls, random sampling, and austere test conditions. The systematic study of these factors and their effect on food behavior has often been left to other disciplines, including those of psychobiology, social and cognitive psychology, nutrition, anthropology and consumer marketing.

The final product of the integration of basic sensory information with cognitive and other higher-order variables is a perception of the stimulus within a complex, contextual background. This is frequently accompanied by a concomitant emotional or hedonic response that falls along a continuum of 'pleasantness/unpleasantness' or 'like/dislike'. This hedonic response is what many investigators choose to call 'acceptance'. By its nature, it is a phenomenological experience. Experimental psychologists would call it an 'intervening variable', because its existence cannot be confirmed directly. In order to quantify or otherwise measure it, the observation of some behavioral response is required, as depicted in Figure 10.1. Regardless of the particular behavioral response that is measured, the sensory and hedonic experience of the food interacts with post-ingestional effects to produce consequences that feedback on learning, memory and bodily states. These, in turn, affect subsequent responses to that food item. This process is reflected by the feedback arrows in Figure 10.1.

The problem that the researcher faces when studying food acceptance is that, while the concept of acceptance is inherently rooted in phenomenology, it must be measured through behavior. Yet the particular behavior that one uses to measure it will greatly affect the interpretation of the phenomenological event itself. For example, physiologists might argue that the frequency of neuronal firing in the lateral hypothalamic

medial forebrain bundle is the best index of the degree of pleasure elicited by the stimulus. Cognitive psychologists might argue that direct, introspective ratings of the degree of pleasantness/unpleasantness by the individual are the best measures, while behavioral psychologists would argue that the only entities worth measuring are overt behaviors, i.e. such things as choice. consumption, complaint behaviors, etc.

Yet each of these measures has shortcomings. Electrophysiological measures must invoke the assumption of 'psychophysical parallelism', i.e. that there is a one-to-one association between neuronal discharges and specific phenomenological experiences. Needless to say, most psychophysiological measures are also highly impractical, except in the most remote and artificial of laboratory settings. Consumption, as a behavioral index, is heavily dependent upon hunger, thirst and other metabolic factors. The alternatives of choice and/or purchase behavior are highly contextually dependent. Moreover, in the real world, these dependent measures are greatly affected by price. availability and other socioeconomic variables that are difficult to control. Direct ratings of food acceptance. while seemingly the least fraught with extraneous influences, are also a form of behavior, both verbal and numerical. As such, the manner in which individuals interpret words and use numbers will influence direct introspective ratings.

As a psychologist. the author considers the phenomenological aspects of food acceptance to be the most interesting and the most challenging of the many problems facing scientists in the field. There is a certain prima facie validity to an individual's self-report that he 'likes' or 'dislikes' a particular food item. As a psychophysicist, the author also believes that the phenomenology of food acceptance can be measured using subjects' direct self-reports. in the same way that subjects' direct self-reports of the perceived taste intensity of a model solution can be used as a valid dependent variable to relate to physicochemical characteristics of the stimulus solution. Thus, the predominant behavioral measure used in the author's research has been direct ratings of food acceptance. The most common operational measure has been a self-report of like–dislike, using a nine-point hedonic scale (Peryam and Pilgrim, 1957). The latter also has considerable practical appeal, because of the 35-year history of food acceptance data collected via this method in the author's laboratory and a predecessor laboratory at the Quartermaster Food and Container Institute in Chicago.

10.1.2 Overview

As mentioned previously, most psychophysicists and other sensory scientists spend considerable time controlling outside influences on their data. Many of these undesirable influences are environmental, inherent to the

testing facility's physical layout, vicinity to other activities, lighting and air exchangers, etc. Other, more insidious influences are brought to the testing situation by the subject. These include physiological, cognitive, social and cultural influences. These influences are much more difficult to control. Not uncommonly, after many years of testing, the sensory scientist comes to find that the very factors that he sought to control become of greater interest than the sensory effects that he/she had previously sought to protect from these influences. So it is that the author's research has slowly shifted from controlling these 'non-sensory' influences to studying them.

The intent in this chapter is to focus attention on a cognitive variable that the author believes has significant impact on food acceptance and general sensory perception. It will begin with a review of certain pieces of data taken from published research that have contributed to the thought process leading to the thesis of this chapter. The review will focus on specific studies and data that suggest that a construct that may be referred to as 'expectations' can contribute significantly to our understanding of food acceptance. This construct will then be further developed with detail of some recent experiments in which expectations have been directly manipulated and their effects on sensory judgment and food acceptance observed.

10.2 The plausible role of expectations in food behavior

It should come as no surprise that the sensory attributes of a food play a significant role in its overall acceptance. Were that not the case, there would be wide-scale unemployment among sensory scientists currently working in the food industry. However, of greater interest to psychologists is uncovering general rules and principles that govern the role of these sensory attributes in food acceptance. For example, it has been well established that there are specific patterns to the growth of pleasantness/unpleasantness as a function of the intensity of food-related sensory attributes. Similarly, there is now a large body of data showing that certain tastes and odors are differentially preferred/rejected at birth. Models have also been constructed to account for changes in these innate preferences/aversions over time. These shifts in preference have been shown to occur through a variety of mechanisms, including mere exposure to previously novel or aversive foods, classical taste/odor aversion conditioning, and sensory specific satiety. In this section are reviewed some of these general principles as they relate to the prediction of food acceptance. However, the focus will be on selected data that suggest that consumers' 'expectations' about the sensory or hedonic properties of food

can have as powerful an effect on perceived food acceptance as the actual physicochemical properties of the food itself.

10.2.1 Oral texture and temperature

On the whole, the effects of oral tactile sensations on acceptability have been less often studied than the effects of other sensory attributes, e.g. taste, odor, appearance. However, the role of texture on food acceptance has received increasing attention since the germinal work of Szczesniak and co-workers (1963, 1971, 1972), who examined consumers' awareness and attitudes toward various food textures. Although much of this research has confirmed that consumers suffer from a general lack of awareness and paucity of language for describing textural sensations, the importance of texture to food acceptance is aptly reflected in the large number of consumers who avoid such texturally unappealing products as squid, raw oysters, brains, liver and tapioca pudding. In fact, several studies have shown that texture is much more frequently cited as a reason for disliking a food than as a reason for liking it (Szczesniak, 1972; Sawyer *et al.*, 1988). Whether such reports are due to innate or acquired dislikes for the textural attributes of these products or may, in some cases, be due to preconceived expectations about the likely texture of these products, is something we will return to later.

Although studies have identified specific textural attributes as important sensory factors in the acceptability of a variety of foods (Hendrix *et al.*, 1963; Schutz *et al.*, 1972; Szczesniak and Kahn, 1971; Yoshikawa, *et al.*, 1970a,b,c; Okabe, 1979; Cardello *et al.*, 1983; Cardello and Maller, 1987; Szczesniak, 1991), the issue of consumer 'awareness' of food texture is critical to understanding its overall contribution to food acceptance. For example, in almost all studies that have been conducted with consumers, flavor is more frequently cited than texture as the reason for liking or disliking a food (see Jerome (1975) for a cultural exception with Afro-Americans). However, one common exception is bland foods, where texture, by default, is more likely to be the focus of consumer attention. The role of awareness or attention to texture can be seen in the data in Figure 10.2. These data are from a study of the relationships between perceptions of texture by naïve consumers and by texture profile panelists who have been trained to attend to the textural attributes of food (Cardello *et al.*, 1982). The data show acceptability ratings of bread products as a function of the instrumentally-determined texture of the bread. As can be seen, the trained panel ratings are much more greatly affected by the rheological variation in the products than are those of the naïve subjects. These results are supported by several other studies (Moskowitz *et al.*, 1974; Sawyer *et al.*, 1984, 1988) in which it has been

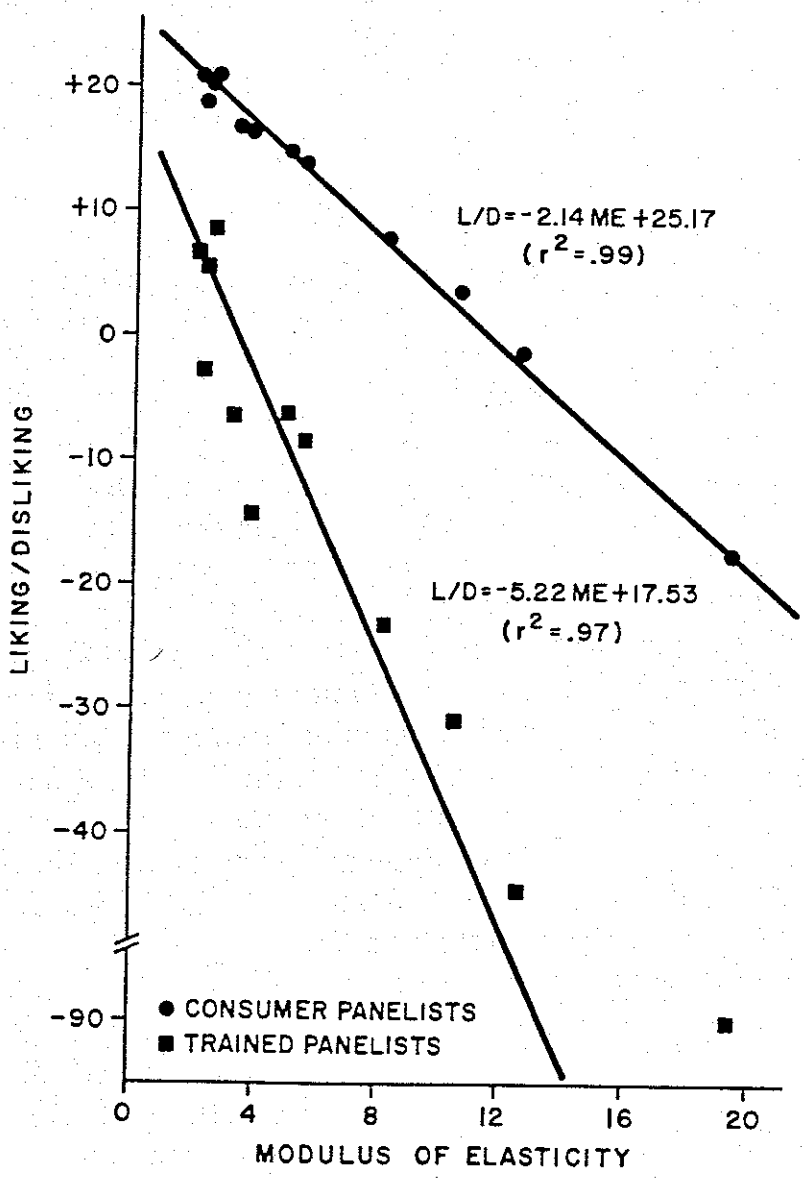


Figure 10.2 Liking/disliking ratings of bread products as a function of the modulus of elasticity (instrumental measure of texture) for both consumer and trained panelists (from Cardello *et al.*, 1982).

shown that the perceptual response range to textural variations in food is broadened with attribute-relevant training, and is consistent with earlier data of Szczesniak (1971) showing a greater awareness of texture among those who attend to food and food textures as part of their daily activities.

In a more recent study, consumer awareness of food geometry was examined by manipulating sensory and situational cues, e.g. sight of the food, manual contact with it, and sequential versus simultaneous presentation, that could aid the discrimination of differences in the size of food samples and associated textural judgments. The results of this study showed a linear relationship between the number of cues provided and

the judged differences in hardness and chewiness of the samples (Cardello and Segars, 1989).

In one of the earliest papers on consumer awareness and/or attention to texture, the suggestion was first made that consumer 'expectations' may influence both the attention paid to texture and overall liking of the food. In this paper by Szczesniak and Kahn (1971) and quoted in Bourne (1982), the statement is made,

> If the texture of a food is the way people have learned to expect it to be, and if it is psychologically and physiologically acceptable, then it will scarcely be noticed. If, however, the texture is not as it is expected to be . . . it becomes a focal point for criticism and rejection of the food.

The critical part of this statement for the present discussion is the association of disconfirmed expectations with negative effect or acceptability. Although the statement is based on data from consumer interviews, the proposed relationship of disconfirmed expectation with decreased acceptance is consistent with other empirical observations.

A similar attribution of the effect of consumer expectations on texture perception has been made by Vickers (1991) to explain the occurrence of outliers in data relating perceived oral crispness and auditory crispness (Vickers, 1982). The outliers were responses to three foods in which oral crispness judgments did not correlate well with auditory crispness judgments. Judgments of oral crispness were lower than judgments based on their sound. The three foods were two types of humidified crackers and blanched celery. The explanation given was that

> judgments of crispness may have been affected by the subjects' expectation for the product. Blanched celery may have been much less crisp than the subjects expected it to be when they picked it up (Vickers, 1991, p. 92).

The implication here is that the judgment of crispness is dependent upon the level of expected crispness in the product and that products that are less crisp than expected are rated lower in oral crispness than products that confirm a given expectation of crispness.

The above quotations have been cited for two reasons. First is to document the fact that the use of the concept of 'expectations' to account for perturbations in both sensory and hedonic data is not new. Although these authors have used the term 'expectations' in a colloquial manner and only as a *post hoc* explanation of the observed data, as will be seen, investigators in other areas have also proposed this concept as an explanatory variable. The second reason is that the statements are relatively clear in focusing attention on the importance of *disconfirmation* of expectations. Disconfirmation and the direction of disconfirmation (better/worse) for hedonic expectations are important to the analysis of alternative cognitive mechanisms that may be responsible for these effects.

The other area of oral tactile sensation that is important for food acceptability is thermal perception. In general, there are three mechanisms by which temperature can affect food acceptance. First is the direct effect that temperature has on the molecular activity of the stimulus. This can produce increases or decreases in the rate that stimulus molecules interact with the receptor surface, thereby altering its sensory profile and, possibly, affecting acceptability. Second are the potential effects that the temperature of the food may have on receptor sensitivities themselves. Lastly are effects that operate through conditioned preferences for certain foods consumed at certain temperatures. Concerning the first two mechanisms, a body of data has accumulated on the effects of temperature on threshold and suprathreshold responses to sapid compounds (Stone *et al.*, 1969; Pangborn, *et al.*, 1970; Moskowitz, 1973; McBurney *et al.*, 1973; Larson-Powers and Pangborn, 1978; Bartoshuk *et al.*, 1982; Calvino, 1986). In a review of this area, Green and Frankmann (1987) concluded that, with the exception of a decrease in the perceived intensity of sucrose at lower temperatures, 'the effect of temperature on taste intensity is not a reliable phenomenon'. These investigators proposed that the lack of reliability was due to the failure to control the temperature of the tongue, not simply the temperature of the solutions, in these studies. In their own studies, Green and Frankmann showed that the temperature of the tongue exerts greater control over the perceived taste intensity of the solutions than does the temperature of the solution. From these data they concluded that temperature has a greater effect on the sensory transduction process than it has on the thermo-molecular properties of the solutions.

What exactly is the relationship between temperature and acceptability for various foods and beverages? Figure 10.3 shows data for the acceptability of thirteen foods and beverages as a function of temperature. As can be seen, most foods that are commonly served hot, e.g. entrée items, increase in acceptability from 40° to 140°F. On the other hand, foods or beverages that are normally served cold, e.g. milk and lemonade, decrease in acceptance with increasing temperature. Products that are served either hot or cold, e.g. coffee, show high acceptance at both temperature extremes, but low acceptance at room temperature (Cardello and Maller, 1982). Lester and Kramer (1991) have also shown that foods that are typically served hot are rated higher in acceptability and are consumed more when heated, as compared to when they are served at ambient temperature.

The differences in preferred temperatures for foods led Zellner *et al.* (1988) to a series of experiments that have also implicated consumer expectations as a factor in food acceptance. In these experiments it was shown that the acceptability of beverages served at different temperatures can be significantly altered by simply changing the subject's 'expectation'

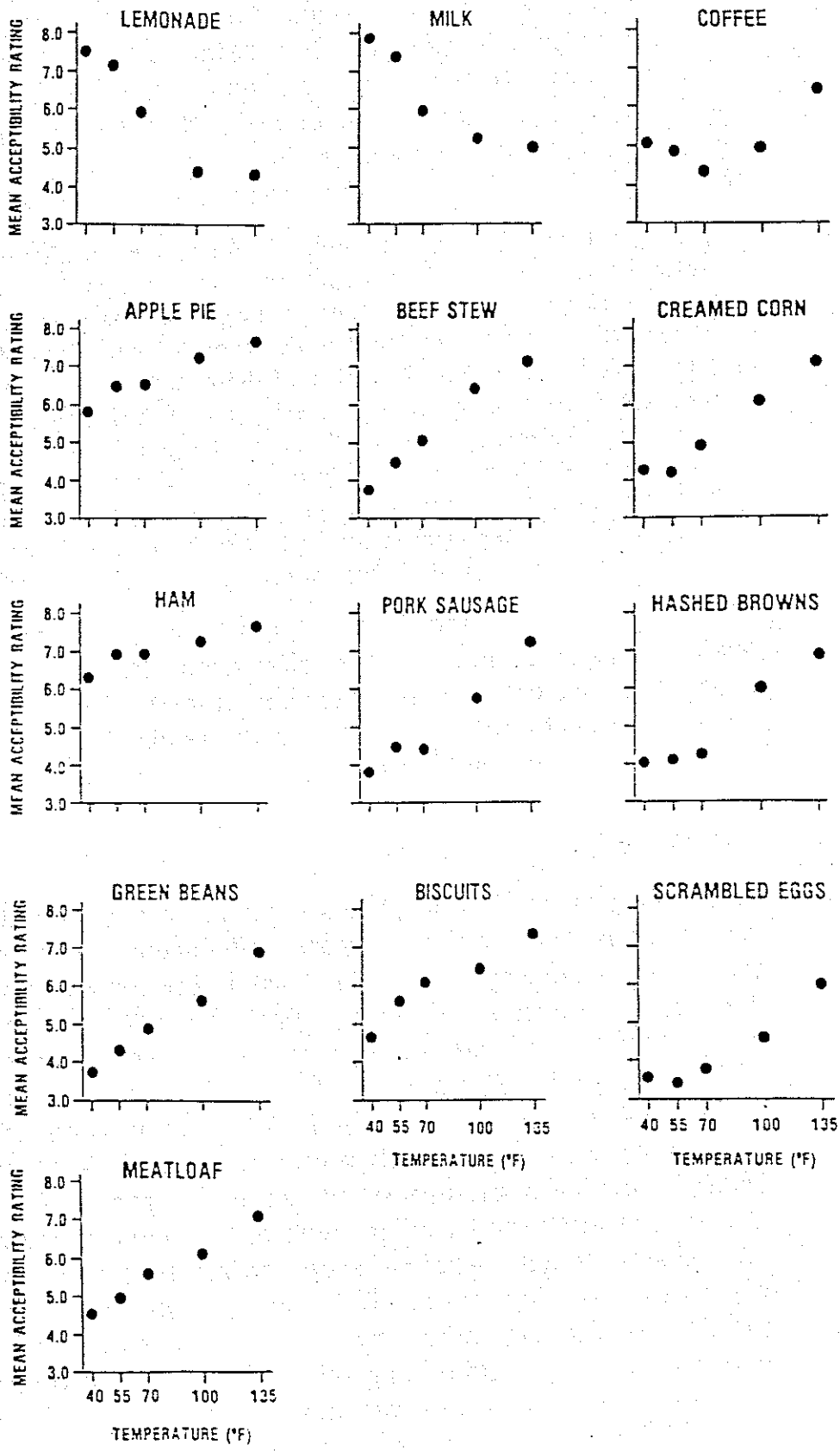


Figure 10.3 Acceptability ratings as a function of serving temperature for a variety of common foods and beverages (from Cardello and Maller. 1982).

concerning the temperature at which the beverage is typically consumed. In their study they used guanabana and tamarind juices that were served cold or at room temperature. One group of subjects was told that the juices are normally served at room temperature, while the other group was given no information. The data showed that the former group gave significantly higher acceptance ratings to the room temperature samples than did the latter group. In their conclusions, Zellner *et al.* state

> Tasting a beverage at an unfamiliar temperature can decrease the degree to which subjects report they dislike the beverage, at least temporarily. This indicates that the rejection of such beverages at certain temperatures is, at least in part, the result of expectations based on learned ideas of appropriateness. Expectations concerning the flavor of these substances at unfamiliar temperatures are worse than the actual experience of drinking them.
>
> Altering the expectations of the subject regarding which temperatures are appropriate and which are inappropriate can also change reports of liking for beverages at different temperatures. If subjects are led to believe that certain temperatures are appropriate for unfamiliar beverages they tend to report that they like them more at the temperatures they are told are appropriate.

Zellner *et al.*, in addition to focusing attention on the concept of 'expectations', also point to the relationship that may exist between the concepts of expectation and 'appropriateness'. The latter concept has been discussed by Schutz (1988) and the reader is referred to this treatment of the concept and its suggested role in food acceptance.

10.2.2 Flavor

While the texture of food products can have a profound effect on perceived acceptability, an even greater influence is exerted by the flavor of food. The first question that we can ask is 'are some tastes/odors innately preferred or rejected?' Certainly there is ample evidence showing that infants reject both bitter and sour tastes and accept sweet tastes (Nisbett and Gurvitz, 1970; Desor *et al.*, 1973, 1975; Lipsitt, 1977; Crook, 1978; Steiner, 1979; Rosenstein and Oster, 1988). In addition, some odors have been shown to be differentially preferred/rejected (Rosenstein and Oster, 1988). These early predispositions appear to remain strong throughout life, so that adult food cravings tend to be characterized by sweet tastes and pleasant smells, whereas aversions are frequently characterized by bitter tastes and foul smells (Blank and Mattes, 1990). However, innate preferences can be altered by experience and/or conditioning. These experimental and conditioning effects can decrease or increase acceptance. In the former case, a vast literature has evolved showing the effects of conditioned taste aversions (Garcia *et al.*, 1966; Garcia and Koelling, 1966) by the pairing of hedonically neutral tastes with illness induced by chemical and radiological means (see Garb and Stunkard, 1974; Berstein

and Webster, 1980; Logue *et al.*, 1981; Pelchat and Rozin, 1982; and Bartoshuk and Wolfe, 1990 for representative studies with humans). In the case of preference conditioning, positive effects on acceptance have been found by simple repeated exposure to a novel taste/odor/food (Torrance, 1958; Capretta and Rawls, 1974; Domjan, 1976; Birch *et al.*, 1987; Davis and Porter, 1991), through flavor–flavor associations (Holman, 1975; Fanselow and Birk, 1982; Zellner *et al.*, 1983; Breslin *et al.*, 1990), and through pairing of flavors with post-ingestional satiety signals (Booth, 1972, 1981; Booth *et al.*, 1982; Tordoff *et al.*, 1987; Birch *et al.*, 1990). The conclusion to be drawn from these effects of learning and conditioning is that humans and other organisms have predispositions to accept or reject certain tastes and odors, however these predispositions are malleable and can be overridden by a variety of experiential factors.

Whether flavor preferences/aversions are innate or learned, it is obvious that the taste and odor of food has profound effects on its acceptability and consumption. The evidence of this fact is so pervasive in daily life that no purpose is served in documenting this point. However, there are several critical facts about the relationship between taste, odor and acceptability that are worthy of consideration here. For example, while it is well established that taste and odor intensity grow as a power function of physical intensity (Stevens, 1957), acceptability does not follow this or any other simple monotonic relationship. In the case of most sensory attributes that are acceptable throughout a broad range of their intensity continuum, e.g. sweetness, acceptability (pleasantness) increases with increasing physical intensity up to a certain point, whereupon pleasantness declines with further increases in intensity. The optimal level of acceptability is often referred to as the 'breakpoint' or 'bliss' point for that continuum (Moskowitz *et al.*, 1974). In the case of sensory attributes that are unpleasant throughout most of their sensitivity continuum, pleasantness declines monotonically with increasing concentration.

Of special interest to our present considerations is the fact that these relationships between sensory attributes and acceptability can be entirely reversed depending upon the context in which the flavor attribute appears. Take for example the data in Figure 10.4. Numerous psychophysical studies of sweetness have utilized sugar-in-water solutions as test stimuli. Consistent with the relationships just discussed, these studies have shown sweetness intensity to increase with increasing concentration, while the curve for pleasantness/preference increases up to a certain concentration and then flattens or decreases. In this study (Maller *et al.*, 1982), increasing concentrations of sucrose were tested in either a water solution (Figure 10.4a) or in eggs (Figure 10.4b). By following the pleasantness and preference ratings as a function of sucrose concentration, one sees that in water, the pleasantness and preference curves behave as expected, increasing to the point where they reach an asymptote and/or decline.

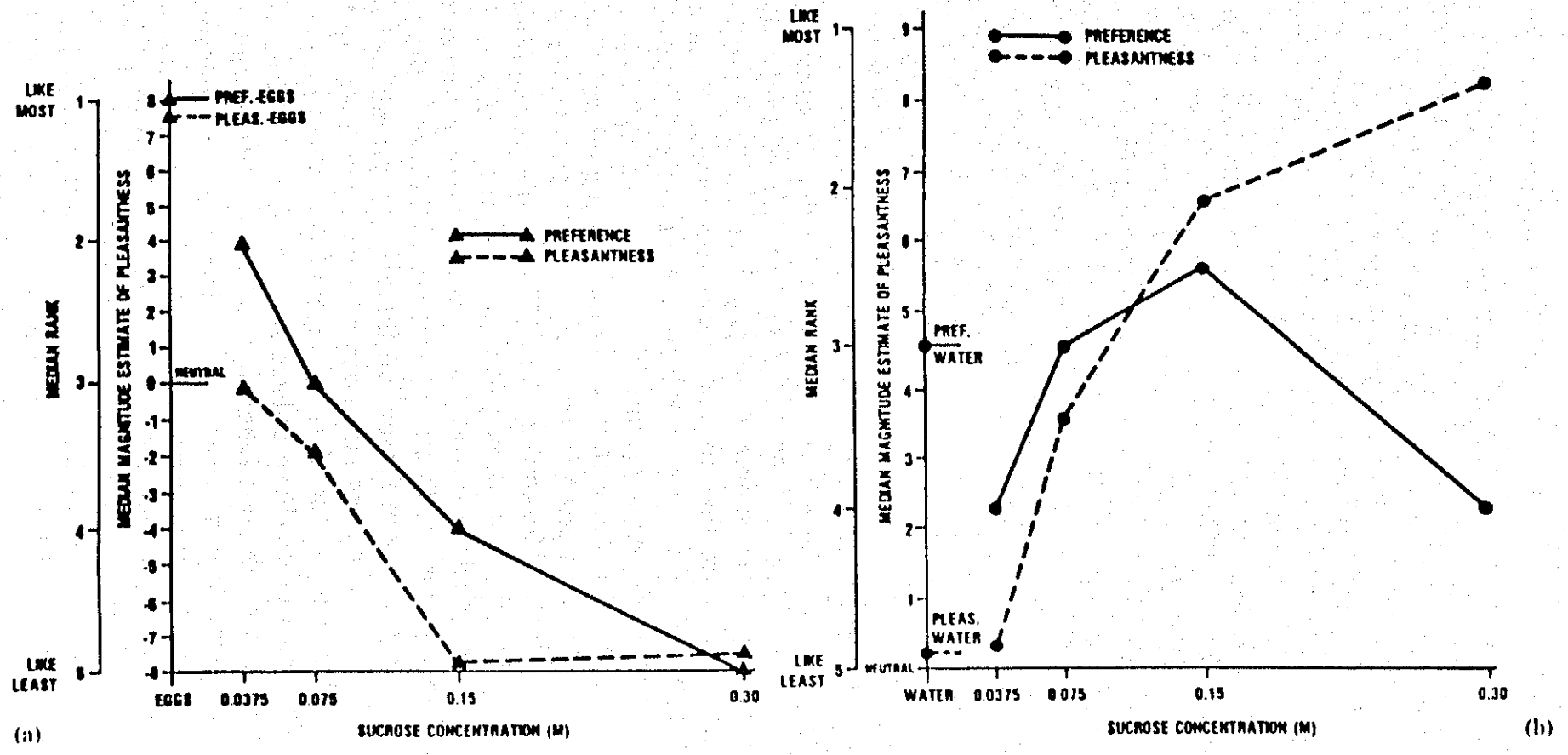


Figure 10.4 Preference and pleasantness as a function of sucrose concentration as judged in (a) scrambled eggs or (b) water solutions (from Maller *et al.*, 1982).

However, in eggs the same concentrations of sucrose result in pleasantness and preference curves that decline monotonically and then level off. Why should the pleasantness of sucrose behave so differently when perceived in eggs rather than water? One obvious answer is that sweetness is not normally associated with eggs. One might say that 'sweetness' is not an attribute that one 'expects' in eggs. The context in which tastes/odors are experienced is critical to the degree of pleasantness or unpleasantness that they elicit and no taste or odor can be said to elicit invariably pleasant or unpleasant sensations, without consideration of the context in which they are presented or the expectations that the context sets.

Studies of contextual effects in flavor perception have frequently focused on the effect of stimulus intensity ranges on the perception of the flavor intensity and pleasantness of test solutions. Most of these studies have manipulated the range of intensities or the frequency of presentation of two or more intensities in a series. Thus, Riskey *et al.* (1979) demonstrated that intensity ratings of the sweetness of fruit flavored drinks were increased when the samples were presented in a series of low sweetness samples, whereas the same samples were rated as less sweet when presented in a series containing higher intensity samples. Ratings of pleasantness of the samples were also affected by this contextual manipulation, with lower concentrations of sucrose judged to be more pleasant in the high intensity context and vice versa. McBride (1982, 1985) has shown similar effects for ratings of the sweetness and pleasantness of milk drinks and for the flavor intensity and pleasantness of fruit-flavored drinks presented in either high or low concentration series. Other effects reported by Riskey (1982) and Lawless (1983) for the saltiness of soups, Johnson and Vickers (1988) for the sweetness of lemonade, and Kroeze (1982) for the degree of suppression of saltiness/sweetness in NaCl/sucrose solutions, have all provided support to relativistic models of perception, e.g. adaptation-level theory (Helson, 1964) and range-frequency theory (Parducci, 1965; Poulton, 1968).

More recent research on contextual effects on flavor have begun to examine the role that the quality of the stimuli play in such effects. For example, Lawless (1989) and Lawless *et al.* (1991) have shown context dependent changes in the perception of odor quality. In these studies ambiguous odors of citrus/woody character were perceived as more woody when presented within the context of pure citrus odors, but more citrus-like when presented among pure woody odors. Marks, in several recent studies, has examined the role that the qualitative similarity between subsets of stimuli that differ in both quality and intensity has on contextual intensity effects (Marks *et al.*, 1986; Marks, 1988; Marks and Warner, 1991; Rankin and Marks, 1991). Using both auditory and flavor stimuli, these investigators have shown that the magnitude of contextual effects on intensity is a function of the qualitative similarity between the

contextual stimuli and the test stimuli. For example, saltiness was decreased to a greater extent when presented within the context of a series of high intensity NaCl stimuli and low intensity sucrose solutions than when presented within the context of high intensity NaCl stimuli and low intensity NaCl/sucrose mixtures.

In the studies by Marks, the two stimulus subsets always differed in intensity ranges. However, in a somewhat obscure experiment conducted by Carlsmith and Aronson in 1963, a series of iso-intense solutions of sucrose and quinine sulfate was presented to subjects. These investigators were also looking for differential intensity effects as a function of stimulus quality. However, rather than manipulating intensity, these investigators manipulated the 'expected quality' of the stimulus. This was accomplished by providing the subjects with cues to the quality of the stimulus to be presented. In some cases the stimulus that was presented was consistent with the cue, i.e. sucrose was expected/sucrose was presented, in other cases it was inconsistent with the cue, i.e. sucrose expected/quinine presented. In all cases, judgments were made of the perceived intensity of the solutions. The results of this study showed significant differences in the perceived intensity of the solutions on trials when the subjects were given the stimulus that was not cued to them, as contrasted to trials when they were given the stimulus that was cued. However, consistent with the evolving theme of this chapter, this effect only occurred when the subject had a strong 'expectation' for the solution (defined by a criterion number of 'correct' trials preceding the target trial). Moreover, the effect on perceived intensity was different depending upon the quality of the stimulus, i.e. sucrose solutions which disconfirmed an expectancy were rated less sweet than sucrose solutions that confirmed an expectancy, but quinine solutions which disconfirmed an expectancy were rated more bitter than quinine solutions that confirmed an expectancy. At first glance, the differential intensity effects by quality appear inexplicable. However, the authors reconciled these data by proposing that, in both cases, the disconfirmed sensory expectations produced negative affect, a situation that would be reflected in both lower sweetness and higher bitterness ratings.

Carlsmith and Aronson's (1963) data were the first to draw a link between sensory perception of flavor, expectations, and affect (acceptability). The authors interpreted their results in terms of cognitive dissonance theory (Festinger, 1957), stating that 'if a person expects a particular event (X) and instead, a different event (Y) occurs, he will experience dissonance. Consequently, he will judge Y to be less pleasant than if he had had no previous expectancy'. While this interpretation is, in fact, consistent with dissonance theory, as we shall see, this is only one possible model to account for the results observed when product expectations are disconfirmed.

10.2.3 Appearance: food and its packaging

If one considers the numerous and varied ways in which consumers come into contact with food, it would be safe to conclude that the appearance of the food and/or its package constitutes the first sensory impression of the product. Appearance includes such basic sensory attributes of the food as its color, shape and size, as well as more complex attributes, such as translucency, gloss, or surface texture. Of all these visual aspects of food, the effect of color is the most dramatic, universal, and well-studied.

Some of the earliest experimental work on the effects of color on food perception and acceptance was conducted over a half-century ago by Moir (1936) and Dunker (1939), who first showed the strong association between a food and its color. Since that time numerous studies have shown the dramatic effects of color on taste recognition and taste intensity (Pangborn, 1960; Maga, 1974; Kostyla and Clydesdale, 1978; Johnson *et al.*, 1983; Christensen, 1983; Roth *et al.*, 1988), on flavor detection and identification (Dubose *et al.*, 1980; Urbanzi, 1982; Kanig, 1955; Hall, 1958) and on acceptability (Schutz, 1954; Worthington, 1960; Maga, 1973; SIK, 1976; Tuorila-Ollikainen *et al.*, 1984; Dubose *et al.*, 1980).

In our own laboratory, we have demonstrated important effects of color on the consumer perception and acceptability of a wide range of beverages, bakery products, meat and fish (Dubose *et al.*, 1980, 1981; Cardello *et al.*, 1983; Sawyer *et al.*, 1988). Perhaps most interesting for its possible relationship to consumer expectations are some data on inappropriate food colors. The data shown in Table 10.1 are taken from a study in which the stimuli consisted of three flavors of fruit drink (cherry, orange and lime) and a flavorless control (Dubose *et al.*, 1980). Each was prepared in a red, orange, green or colorless version using typical fruit-beverage color additives. Samples were presented in random order to subjects who were asked to identify the flavor of the beverage from a list of alternatives. As can be seen, the perception of the flavor identity of the beverage was significantly affected by the color of the beverage. As the color of the beverage changed from the one normally associated with its flavor to one not normally associated with it, a significant percentage of the perceived flavor identifications shifted from the 'correct' flavor to the flavor one would expect for that color. This effect is most evident in the flavorless sample, where the greatest percentage of flavor identity responses were for the flavor commonly associated with the beverage's color. In a similar but more recent study, inappropriately colored fruit-flavored beverages were found to both produce lower accuracy in flavor (odor) identification and result in reduced acceptance as compared to appropriately colored beverages (Zellner *et al.*, 1991).

In another often cited experiment (Wheatley, 1973), the effect of disconfirmed color expectations on food acceptance was more dramatically

Table 10.1 Data from a study of the effects of atypical colors on flavor identification of beverages. The cell entries are the percentages of consumer flavor responses, collapsed according to flavors with similar color associations, made to each beverage color/flavor combination. As can be seen, the color of the beverage increases the likelihood that the flavor will be perceived as being one that is normally associated with that color

	Test beverage															
	Cherry flavored				Orange flavored				Lime flavored				Flavorless			
Flavor response	Red	Orange	Green	Colorless	Red	Orange	Green	Colorless	Red	Orange	Green	Colorless	Red	Orange	Green	Colorless
Cherry/strawberry/raspberry	92.6	51.8	44.4	55.5	44.7	3.7	–	3.7	33.3	–	–	–	33.3	–	–	11.1
Orange/apricot	–	29.6	3.7	3.7	33.3	81.5	29.6	29.6	3.7	59.2	–	3.7	–	29.6	–	3.7
Lime/lemon–lime	–	3.7	37.0	14.8	11.1	3.7	40.7	22.2	33.3	22.2	85.1	66.7	–	–	40.7	–
Lemon/grapefruit/apple	3.7	7.4	3.7	18.5	–	3.7	14.8	29.6	3.7	11.1	3.7	14.8	14.8	14.8	11.1	22.2
Blueberry/grape/other	3.7	7.4	11.1	7.4	7.4	3.7	11.1	3.7	7.4	3.7	7.4	7.4	11.1	11.1	7.4	14.8
No flavor	–	–	–	–	7.4	3.7	3.7	7.4	18.5	3.7	3.7	7.4	40.7	44.4	40.7	48.1

Source: Dubois *et al.*, 1980.

demonstrated by having subjects eat a 'normal' meal under light-masking conditions. At a specified time during the meal, normal lighting was resumed, revealing to the subjects blue steak, green french fries, and red peas. Subjects were reported to have become nauseated from the sight of the food. Similar but less dramatic effects of inappropriate food colors frequently occur when naïve consumers encounter such common supermarket products as white mint ice cream, brown eggs, brown (over-aged) meat, or green apples/bananas. Common explanations of these color effects on food acceptance range from innate neophobia (the item is rejected merely because it is novel) to learned associations between the inappropriate color and other negative qualities normally associated with that color in food, e.g. the case of unripened or spoiled foods. However, in keeping with the thesis presented in this chapter, it is suggested that many of these color effects can be explained as resulting from disconfirmed consumer expectations. That is, the common factor in most of these cases is that sensory expectations about the normal appearance of these foods have not been met. The normal flavor and texture of the meat, peas, and french fries that were consumed in the dark led to normal expectations about their color that were not met when the lights were turned on; the white color of the mint ice-cream led to expectations about its likely flavor (vanilla) that were not met; and the name, shape and other situational cues normally associated with the supermarket eggs, meat, and fruit all led to certain sensory expectations about the color of these products that were not met. In the case of the colored beverage studies, one can interpret the data of Dubose *et al.* (1980) as showing that the color of the beverages led to specific sensory expectations about their flavor. To the extent that the flavor was ambiguous, these expectations affected subjects' flavor responses in the direction of the expected flavor. Moreover, in the study by Zellner *et al.* (1991) the lower acceptability of inappropriately colored beverages is consistent with an interpretation of decreased affect under conditions of disconfirmed expectations. The mechanisms by which such effects on sensory perception and acceptance may occur is, as yet, unclear, but several alternative mechanisms will be discussed later in this chapter.

Although the visual appearance of the food itself is a powerful influence on its acceptability, so too is the visual appearance of its package, i.e. its shape, color, design, and associated logos, symbols, brand and item names (Hutchings, 1977). Since brand and item names are primarily ideational, they will be discussed separately. However, concerning the effects of package appearance, US military ration packages serve as an excellent model by which to examine the role of package-induced expectations, because ration packages have traditionally been of drab color with no distinguishing designs, logos, or brand names. In a recent set of studies aimed at developing more consumer-friendly packages for rations,

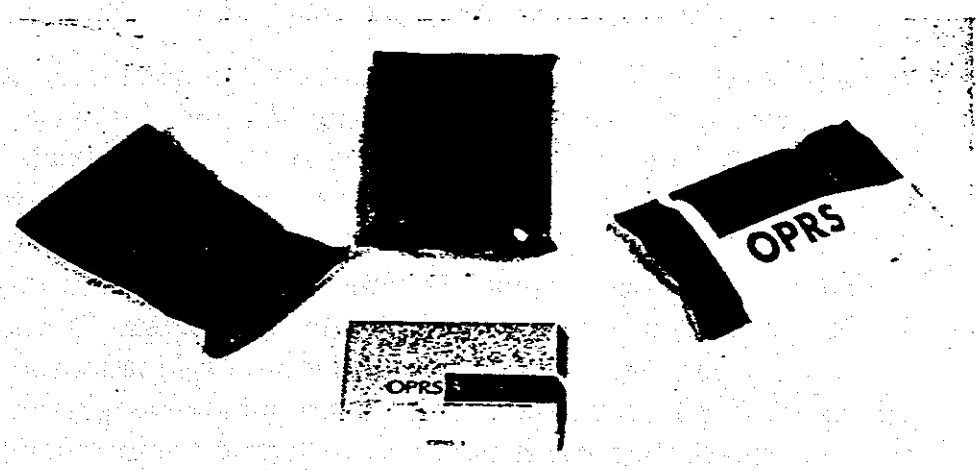


Figure 10.5 Three experimental ration packages designed with commercial-like graphics and the current military package design (center, top).

the effect of package appearance on food acceptance was studied. Four test packages were developed (Figure 10.5). Three of the packages (two zipper-sealed pouches of different colors/designs and a paperboard box) were designed with brighter, more attractive colors, and commercial-like designs. The fourth was a design copy of the existing military packaging for the MRE (Meal Ready-to-Eat) ration. All four packages were labeled with the acronym 'OPRS' to represent the name of a fictional ration system.

One hundred and eighty-three soldiers were shown the four packages in an incomplete block design and were asked to rate the packages on a variety of appearance and functionality attributes (Kalick and Cardello, 1991). Relevant to the issue of food expectations, soldiers were also asked to rate 14 attributes of the food contained inside the packages (without seeing or tasting them). Analysis of the data showed significant differences in the ratings assigned to the food products inside the packages. For instance, the food contained in both the zipper-sealed pouches and the paperboard box was perceived as better tasting, having higher quality ingredients, being more appetizing and being more likely to be made by a reputable company than the food in the standard MRE package. Soldiers also agreed that the commercial-like zipper-sealed packages and box were more likely to contain 'food I like' than the standard MRE. In addition, the food contained in the zipper-sealed pouches was perceived as significantly fresher tasting, easier to clean-up and more natural looking than food contained in either the box or the standard MRE. Since the test subjects did not actually taste or consume the food inside the package, what is the likely mechanism by which ratings of the food were affected? One explanation is that the brighter, more commercial-like packaging led subjects to expect better quality food

and that their ratings reflected this higher expectation. A generalized 'halo effect' is also a possibility, where the novel packaging might be expected to elicit more positive ratings of any and all aspects of the ration and consumption situation.

In a second study, commercial packages and brand names were examined for their effect on ratings of both acceptability and food intake, not simply attitudes (Kramer *et al.*, 1989). In this study subjects consumed and rated the acceptability of a pudding served either in a plain white package, in one of two different military packages, or in its normal commercial package. Consumer ratings of the acceptability of the pudding and the total number of grams consumed were significantly higher when the pudding was packaged in its commercial brand package than in any of the other three packages.

In a third study, we took a slightly different approach and asked whether the differences in the acceptability of military versus commercial food would be affected by whether they were presented in military or commercial packages (Cardello *et al.*, 1985). Four food items were chosen, such that each was available in both a military-pack version that met military specifications and a commercial version that was a high quality, national brand leader. Both the military and commercial items were presented to different groups of subjects in either the military or commercial packages (packages were emptied and their contents interchanged and repackaged). Subjects were presented items in their test packages, they opened and tasted them, and rated them for acceptability. The data are shown in Figure 10.6. While no significant differences were found between the acceptability ratings of the military and commercial items when each was presented in military packages, a significant difference was found between the samples when served in the commercial packages. These latter results are somewhat perplexing. The reason is that, while the increased ratings of the acceptability of food served in more visually appealing packages can be easily interpreted as being the result of a generalized learning or 'halo' effect, i.e. positive associations with the package transfer to its contents, the results of this study do not lend themselves to such an interpretation. The reason is that such a 'halo' effect should have produced higher acceptability ratings for all foods presented in commercial packages. The intrinsic quality of the food should have made no difference. There is no justifiable basis by which to account for the differential effects seen in Figure 10.6. In order to account for such effects an explanation that takes into account the interaction of the food with the package is required. A model of packaging effects that is based on the expectations that the package elicits about the sensory and hedonic quality of the food and the degree to which those expectations are confirmed or disconfirmed by the food product can adequately

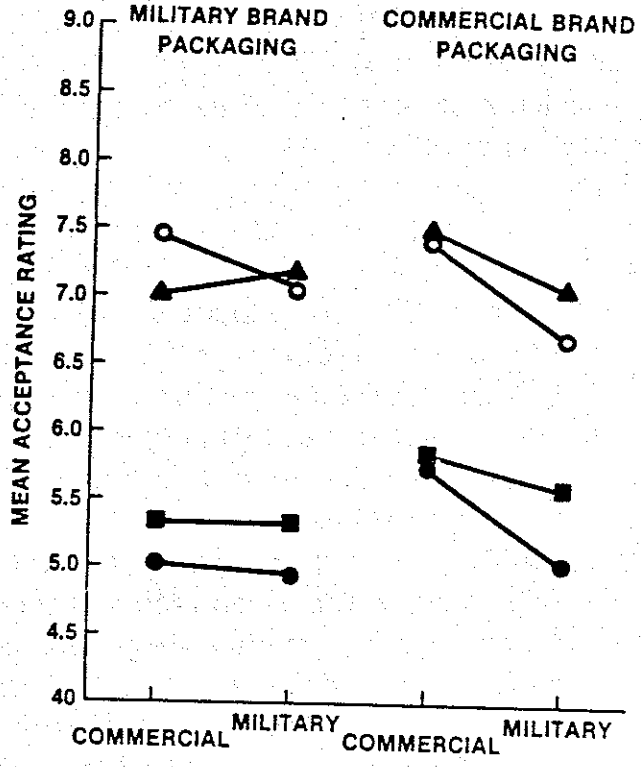


Figure 10.6 Mean acceptability ratings for four food items produced by commercial versus military vendors when presented in either commercial or military packaging. ▲, Grape jelly; ○, salted crackers; ■, non-dairy creamer; ●, instant coffee (from Cardello *et al.*, 1985).

account for these results. That is, high expectations for product quality induced by commercial packaging are met only by high quality foods. Lower expectations induced by military packaging are adequately met by both military food and by commercial foods. If consumer acceptability is a function of the degree of confirmation/disconfirmation of expectations, then the fact that both foods confirmed the minimal quality expectations set by the military packages, but only the commercial food met the quality expectation set by the commercial packages, would adequately account for the differential effects seen in the two conditions.

The implications of an 'expectation' model for food packaging and product marketing are far-reaching. From a strategic marketing standpoint it means that one must make a careful assessment of the product's ability to deliver on the key product elements that are touted to the public through packaging and other forms of advertising and communication. If such communications set realistic expectations that are met by the product, consumer satisfaction will not be detrimentally affected. However, high expectations of quality that are not met by actual product characteristics may lead to varying degrees of discontent. As shall be shown, any adequate model of the effects of disconfirmed expectations should be able to make accurate predictions for situations in which

1. high expectations are disconfirmed by product attributes;
2. low expectations are disconfirmed by product attributes;
3. both high and low expectations are confirmed.

10.2.4 Ideational effects

The foregoing sections have identified several areas of research within the sensory evaluation literature that are amenable to the interpretation that preconcieved expectations about the sensory or hedonic properties of food can affect subsequent perceptions of these properties. Such expectations can be generated by a variety of ideational or cognitive elements associated with the food. For example, when one goes into a restaurant and looks at the menu, one sees a list of food names, usually followed by a short description of the item that is designed to communicate the basic sensory properties of the item, e.g. 'fried in a light batter', 'cooked to a golden brown', 'tender pieces of juicy steak', etc. These descriptions, in combination with past experiences with the item name, create certain expectations about the likely sensory properties of the product, and, in turn, how much it will be liked. It is upon these cognitive data that one selects an item. Thus, if you order 'lasagna', you have certain expectations about what that lasagna will be like, in terms of the product attributes that are personally relevant to you, e.g. the type of sauce, the firmness/tenderness of the pasta, whether it will have meat or not, salt/spice level, etc. These expectations are created by the item name, menu description, previous experience with lasagna in this restaurant, in other restaurants, at home, etc. The hypothesis being presented here is that your satisfaction, liking or acceptability for the lasagna that you receive, is a function, not only of the intrinsic sensory characteristics of the lasagna, but also of the degree to which the lasagna matches or mismatches your sensory and hedonic expectations. A lasagna that is lauded as 'gourmet' by a panel of esteemed chefs, but that does not meet your personal expectations, will not be liked as well as a less acclaimed lasagna that does meet your personal expectations.

The effects of ideational or cognitive stimuli on food acceptance are quite common, occurring with restaurant and institutional foods, as well as with branded, supermarket foods. In the case of institutional foods, expectations can be well ingrained and affect whole classes of foods. The data in Figure 10.7 are ratings of the *expected* acceptability of ten different food items when served in various foodservice settings (full service restaurant, fast food restaurant, airline, foodservice, etc.). The differences in ratings are extreme, from 3.5 for certain types of hospital food to greater than 8.0 for restaurant food. Moreover, the differences in expected acceptability between foodservice settings is constant across food items. Clearly, one must ask how these large differences in expected acceptabi-

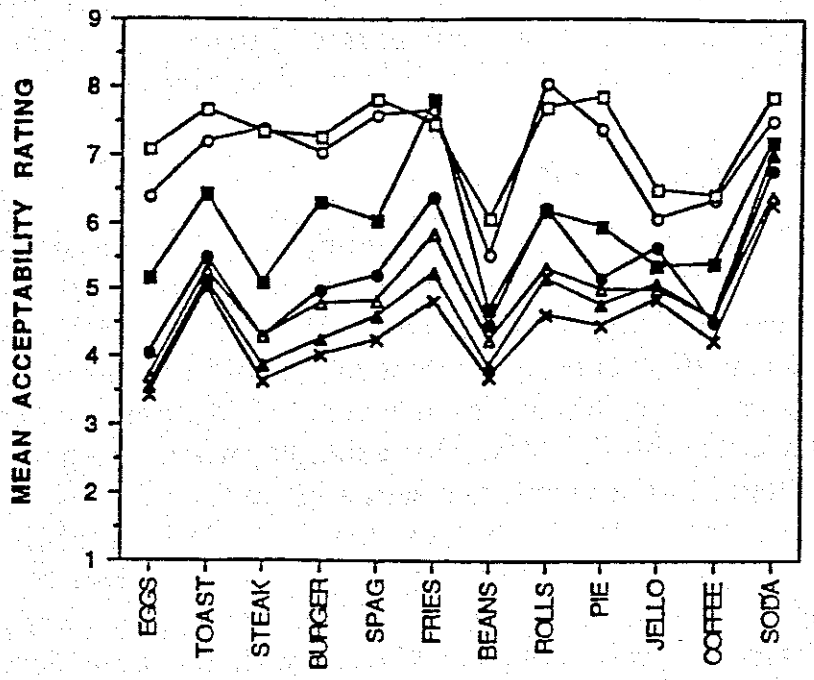


Figure 10.7 Mean 'expected' acceptability ratings for ten food and beverage items under seven possible foodservice operations. Data are in response to food names only. ○, Restaurant; ●, school; □, home; ■, diner/fast-food restaurant; △, military; ▲, airline; ×, hospital.

lities affect actual acceptability ratings. What if the same items were presented to consumers for actual tasting, but under situational conditions that led the consumer to believe he/she was eating airline versus commercial restaurant food? Moreover, what would be the effect on acceptability of serving food that was far better or worse than the established expectation?

In the case of supermarket foods, the studies mentioned previously on the effects of package design could be considered as resulting from ideational cues, especially when item and brand names are included in the packaging. Studies such as those by Pronko and Bowles (1949), Allison and Uhl (1964) Gacula *et al.* (1986) and Sheen and Drayton (1988) have demonstrated significant effects of brand-identity on the perception and rated acceptability of beer, soap products, hot dogs, and cola beverages. In the latter study it was demonstrated that simply labeling a high preference cola with its brand name will increase its acceptance over that given to the same cola in a blind taste test.

Ideational cues are also important in most sensory and food preference testing situations, where significant effort is expended on establishing and controlling sensory-related aspects of the experimental situation. However, many ideational cues are often left to chance or habit. Such

cues as the name given to the item to be tested, its serving vessel, and product or user information can all have important effects on rated acceptability. In sensory studies conducted in our own laboratory, simply changing the name of a product from 'squid' to 'seafood tidbits' and from 'tofu' to 'oriental tidbits' resulted in significant effects on acceptability ratings. Providing certain types of product information, e.g. information on versatily of use, also had positive effects on stated purchase and use among subjects who had not previously tried the product (Cardello *et al.*, 1985). In a recent study we have examined the effect of panelist knowledge concerning the intended use and/or the intended user of a product being tested for acceptability in the laboratory. In the case of intended use, the subjects (200 military personnel of varied ages, 200 civilians under 40 years old and 200 civilians over 40 years old) rated five foods under three informational conditions. Subjects were told that this food would be eaten either (1) in a traditional consumption environment (restaurant, dining hall); (2) in a military field environment; or (3) in a military field environment but only by 18- to 25-year-old soldiers. For all subjects, acceptability ratings of the food were higher under the condition in which subjects thought the food was targeted for field use (Cardello *et al.*, 1991). Moreover, while there were no differences in acceptability ratings between conditions (2) and (3) for the under-40 population, the acceptability ratings were significantly lower in condition (3) for the '40 and over' age group. Clearly, in both circumstances, cognitive factors influenced acceptability ratings. Whether these subjects have lowered expectations for food served in the field than for food served in conventional settings, or if older individuals feel that younger persons have higher expectations for food, is not clear from the testing that was done. Nevertheless, it is clear that such ideational variables can have a significant impact on consumer ratings of food acceptability.

10.3 Consumer expectations and food acceptance

10.3.1 Expectations as a construct

The previous sections have raised the possibility that various results reported in the sensory and food acceptance literature are open to interpretation in terms of the subjects' 'expectations' and their subsequent confirmation or disconfirmation affecting both sensory and hedonic responses. However, most of these studies have merely used the term as a vague, *post hoc* explanatory variable. Expectations as a psychological construct has received no formal discussion and/or treatment in the sensory literature. In contrast to this situation, the concept of 'expectations'

has received much greater attention in the fields of learning and social psychology, where it has played a central role in several cognitive theories of behavior. For example, Tolman (1938, 1951) used the term and the concept of 'expected consequences of behavior' to account for both animal and human learning. Tolman proposed that learned associations were the result of repeated pairings of stimuli that, eventually, cause one stimulus to lead to a belief or expectancy that the next stimulus will occur. In other learning situations, the stimulus leads to expectancy that a reward will result if a particular behavior is emitted in response to the stimulus. In the case of an animal being conditioned in a maze, the start box of the maze serves as a stimulus that leads to the expectancy that another stimulus (food) will be found at the end of the maze. In fact, Tolman's view of the initial stimulus (lights, sounds, etc. in the start box) was that it is perceived within a contextual background that includes the organism's past history of experiences with the stimulus. This view is very similar to contemporary stimulus-context views in perceptual psychology. The parallel between Tolman's analysis of animals running a maze for food and our considerations of the effect of expectations on human hedonic responses to food, is best seen when one considers what happens when the maze is correctly run and either no food is found in the goal box or a negative stimulus is found in the goal box. Under these conditions, the expectancy is disconfirmed. In learning theory these situations are referred to as 'extinction', whereupon the belief/expectancy on subsequent occasions is reduced or modified, and 'punishment', a negative hedonic experience that also produces a reduction in response stength. The parallels between Tolman's animals running mazes without 'expected' rewards and humans encountering products that fail to meet 'expected' standards are obvious.

Tolman was not the only psychologist to give attention to the concept of expectations. Meehl and MacCorquodale (1951), MacCorquodale and Meehl (1953), and MacCorquodale *et al.* (1954) gave the concept explanatory status in their theory of motivation, as did Rotter (1955) in his theory of social learning, and Atkinson (1954, 1957, 1958) in his theory of achievement motivation. These theories are now generally known as Expectancy × Value theories (see Feather, 1982, for a review). Along with Adaptation Level Theory (Helson, 1964) and Cognitive Dissonance Theory (Festinger, 1957), this class of theories places emphasis on the fact that the actual stimulus in any situation is the relationship between the objective stimulus and prior experience or context. Perception and overt behavior are both held to be determined by relativistic mechanisms.

10.3.2 Expectations: sensory versus hedonic

Although learning and social psychologists have utilized the construct of 'expectations', a closer examination of the construct and its potential use in sensory research is needed. In most sensory applications 'expectations' can be thought of as being of two general types: (1) a sensory-based expectation, i.e. a belief that the stimulus (food product, etc.) will possess certain sensory attributes, each at certain intensities, or (2) an hedonic-based expectation, i.e. a belief that the product will be liked/disliked to a certain degree. Examples of sensory expectations include those that are likely to operate in the restaurant 'menu' situation where specific product attributes are implied by the menu description, and in the studies of inappropriately colored foods and beverages, and expected food temperatures. Examples of hedonic expectations include those that are likely to occur in response to new package designs and brand labels, or when other 'ideational' stimuli elicit a general expectation for a good or poor product. In certain situations, both types of expectations may be elicited simultaneously. A mismatch between expected and actual sensory attributes or between expected and actual liking will result in 'disconfirmation'. In the case of disconfirmed hedonic expectations, the disconfirmation can be positive (the stimulus/product is better than expected) or negative (the stimulus/product is worse than expected).

10.3.3 Models of the effect of disconfirmed expectations

Working with the notion that there are two distinct types of expectations that consumers may have about food, the next question is how the confirmation or disconfirmation of these expectations affects food perception and acceptance. Although sensory scientists have given oblique reference to the concept of expectations, no attempts have been made to formalize predictive models of these effects. However, for many years, market researchers have addressed the question of how the failure to deliver on advertising promises affects consumer satisfaction with products. In fact, a number of predictive models have been proposed to explain the effect of disconfirmed expectations on consumer satisfaction/dissatisfaction with such varied consumer products as vacuum cleaners, ballpoint pens and restaurant services. While the interested reader is referred to Insko (1967), Oliver (1977a,b, 1980), Latour and Peat (1979) and Oliver and DeSarbo (1988) for reviews of this literature, the essential elements of these theoretical models and their application to sensory and food acceptance research follows.

Current theoretical treatments of the effect of disconfirmed expectations can be reduced to four distinct models. These are the assimilation model (Hovland *et al.*, 1957; Sherif and Hovland, 1961; Olshavsky and Miller,

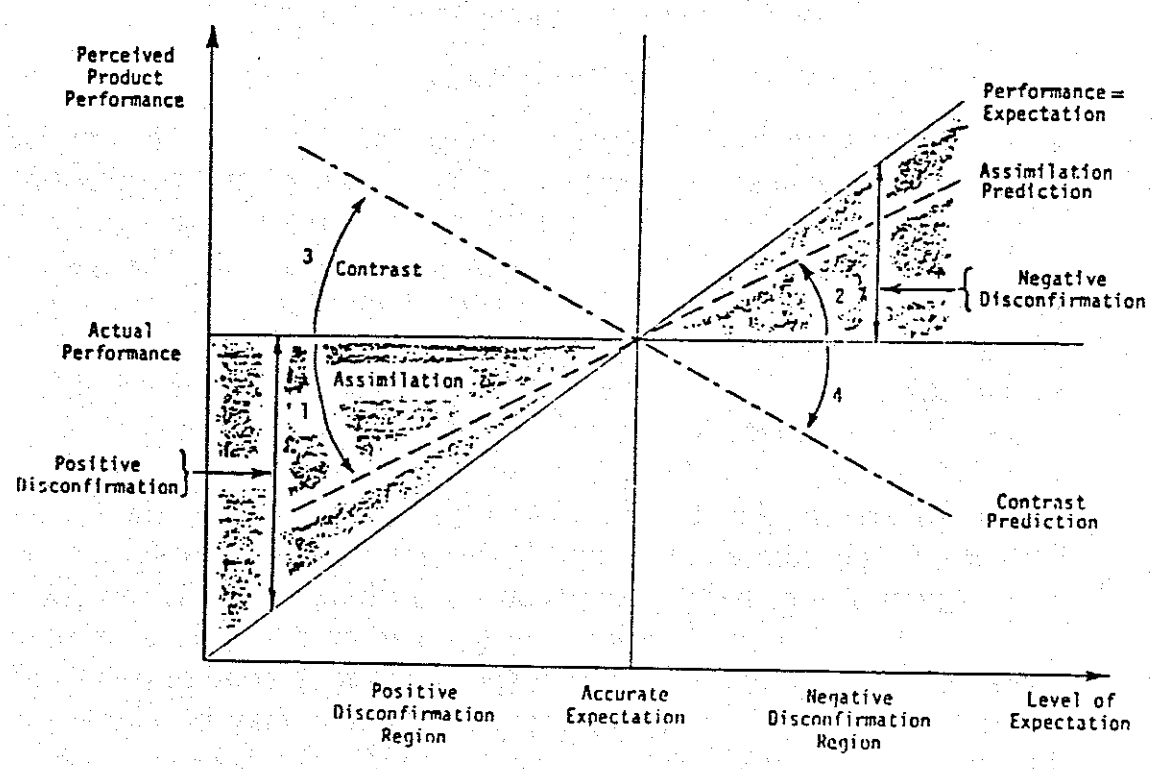


Figure 10.8 Assimilation and contrast model predictions of post-exposure product performance (from Oliver, 1977b).

1972; Olson and Dover, 1976, 1979), the contrast model (Hovland *et al.*, 1957; Sherif and Hovland, 1961; Dawes *et al.*, 1972), the assimilation-contrast model (Hovland *et al.*, 1957), and the generalized negativity model (Carlsmith and Aronson, 1963). These models can be differentiated on the basis of their predicted effects on perceived product performance in response to positive and negative disconfirmation. Figure 10.8 is taken from Oliver (1977b) and shows the specific predictions of the assimilation and contrast models. Predictions of the assimilation-contrast and generalized negativity models can also be inferred from this figure.

In Figure 10.8, the abscissa represents the consumer's level of expectation for the product and the ordinate represents perceived product performance, i.e. level of satisfaction/dissatisfaction or, in our case, level of liking/disliking. The diagonal line extending from the origin maps the points where product performance matches expectations. For some arbitrary product, 'actual performance' is represented by the horizontal line in the figure. For this product, expectation and product performance 'match' at the point of intersection with the diagonal line. Here, all models predict that perceived product performance will equal actual product performance. However, if actual performance is held constant and the level of expectation is varied, then positive disconfirmation (actual performance > expected performance) or negative disconfirmation (ex-

pected performance > actual performance) occurs, as indexed by the vertical distance between the level of actual performance and the point of intercept on the diagonal line.

Regardless of whether positive or negative disconfirmation occurs, the assimilation model predicts that perceived product performance will assimilate (become similar to) the level of expectation, as shown by arcs 1 and 2, respectively. Such a model might be used to account for the data from studies on food packaging and branding, where 'better' brands and 'better packaging' increase acceptability of the food, while generic or institutional brands and/or poor packaging decrease acceptability. The contrast model, on the other hand, predicts that perceived product performance will move in the direction opposite to the expectation. This effect is shown by arcs 3 and 4. A generalized model of this form does well in predicting the range-intensity context effects discussed earlier, where test stimuli undergo contrast effects and are judged as less intense within the context of a high intensity series, but more intense within the context of a low intensity series. Such a model can also be used to explain the hedonic effects reported by McBride (1985), in which acceptability was shown to be lowered when the sample was presented within a context of high acceptability samples and elevated when presented within a context of low acceptability samples.

The assimilation-contrast model is a hybrid form of the models just discussed. This model predicts that consumer satisfaction/dissatisfaction follows assimilation model predictions under conditions of low positive or low negative disconfirmation, but follows contrast model predictions under conditions of high positive or high negative disconfirmation. In other words, this model predicts that assimilation will occur when the actual sensory or hedonic attributes of the product differ only slightly to moderately from expectations. However, if the product differs significantly from expectations, the difference between expectation and reality becomes too large and a contrast effect occurs.

The last of the four models is the generalized negativity model. It predicts that perceived product performance decreases under all conditions of disconfirmation. This model is consistent with the cognitive dissonance model discussed earlier, and can account for such data as those of Carlsmith and Aronson (1963), in which negative affect occurs under all conditions of disconfirmed expectations.

10.3.4 Measuring expectations and confirmation/disconfirmation

In order to empirically study the effects of disconfirmed expectations on food acceptance, an operational definition of expectations and related constructs is needed. A casual examination of the kinds of verbal behavior that are commonly used in reference to food expectations can

provide some insights. Statements that come to mind include: 'This ice cream is so creamy, you'll love it', 'My aunt's apple pie is the best you'll ever taste', 'If you like chewy cookies, taste these' and 'I hope the food here is as good as they say'. Such examples confirm the fact that some expectations are sensory based, e.g. *creamy* ice cream and *chewy* cookies, and some are purely hedonic, e.g. '*best* pie you'll taste' and 'food as *good* as they say'. Examples of post-consumption comments that reflect the confirmation/disconfirmation experience include 'It didn't have the right taste', 'It was done just right', 'It wasn't what I expected' or 'I didn't like it, it was too dry, salty, rich, . . . etc.'.

In our initial research on this concept and its role in food acceptance, we began by developing operational measures by which to index sensory and hedonic expectations and associated measures of confirmation/disconfirmation. The approach was to select measures that have operational validity based on well-founded roots in traditional sensory methodology. In the case of hedonic expectations, we have operationalized its definition as 'the expressed degree of anticipated liking for a future stimulus'. The method by which we have quantified it is through a direct rating of expected or anticipated liking using a traditional nine-point hedonic scale. For example, a subject may be posed the following situation and question: 'Shortly you will be presented with a serving of orange juice. How much do you expect to like it?' The response options given to the subject range from 1 = dislike extremely to 9 = like extremely, with 5 = neither like nor dislike. The methodology is parallel to standard hedonic scaling methods (Peryam and Pilgrim, 1957), except that the judgment is made prior to presentation of the stimulus and is a judgment of 'expected liking'. In the case of sensory expectations, the approach is somewhat different but consistent with established methods for assessing the sensory properties of food. In this case subjects are asked to generate an 'expected sensory profile' of the anticipated product. That is, subjects generate a series of intensity ratings for each of a variety of salient sensory attributes of the product. Subjects are asked to rate the 'expected or anticipated intensity of the following attributes of the product . . . '. A variety of intensity scales may be used, as long as provision is made for a 'zero' or 'not present' response.

Using these operationalized measures of sensory and hedonic expectations, measures of confirmation/disconfirmation were then developed using 'the degree of difference between expected and actual sensory or hedonic properties' as a definition of disconfirmation. In the case of hedonic disconfirmation, we have chosen the signed difference between expected and actual acceptability as a measure of positive and/or negative disconfirmation. For sensory disconfirmation we have used the unweighted average difference between the expected and actual attribute intensity ratings as a measure.

10.4 Experimental studies

10.4.1 Sensory disconfirmation

If sensory experience precedes hedonic response, then sensory disconfirmation must precede hedonic disconfirmation. However, once the hedonic response occurs, we can justifiably ask how sensory disconfirmation affects acceptability and how inferred measures of sensory disconfirmation and/or hedonic disconfirmation relate to direct post-stimulus ratings of confirmation/disconfirmation. Thus, in one of the first experiments in which we employed these measures, we examined the effect of sensory disconfirmation on acceptability and compared inferred measures of disconfirmation to a direct, self-reported measure of confirmation/disconfirmation (Cardello and Sawyer, 1992). The samples in this study consisted of a water soluble, edible film that had been used to coat a candy product. Thirty-eight consumers, who had no prior experience with edible films, served as the subjects. Subjects were informed about the uses of edible coatings in foods, but no information was provided about the sensory properties of the coatings. Subjects were instructed on how to produce an expected sensory profile of the edible coating and rated the expected intensity of nine salient sensory attributes that had been selected during pilot tests. In addition to judging the expected sensory attributes of the product, subjects rated the expected acceptability of the product.

After making these judgments, subjects were presented the coated product and were asked to generate a 'perceived' sensory profile, using the same set of nine attributes. Subjects also

1. judged the acceptability of the coating;
2. estimated the degree to which the edible coating matched/mismatched their initial expectations;
3. rated their likelihood of purchasing the product.

Subjects used a seven-point scale that varied from 1 = 'did not match my expectations' to 7 = 'matched my expectations perfectly' to directly rate the degree of confirmation/disconfirmation. The inferred measure of sensory disconfirmation was calculated as the unweighted mean of the absolute differences between the intensity ratings for the nine sensory attributes on the 'expected' and 'perceived' profiles.

Figure 10.9 is a plot of the difference between expected acceptability of the edible coating and its rated acceptability after tasting (post-test minus expected) as a function of the inferred measure of sensory disconfirmation. As sensory disconfirmation increased, post-test acceptability decreased relative to expected acceptability. Thus, when the sensory attributes of the product did not differ from expectations, judged acceptability was equal or higher than expected acceptability. However, when the product

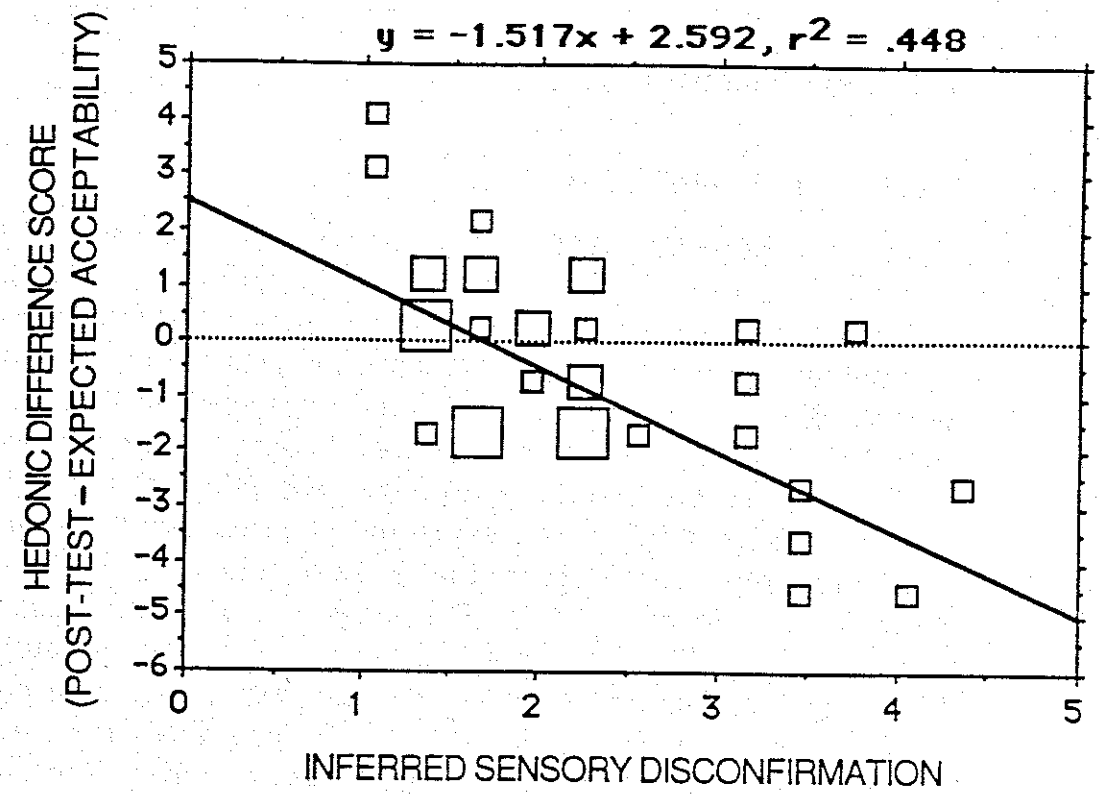


Figure 10.9 Linear regression plot of the hedonic difference score (post-test minus expected acceptability) as a function of inferred sensory disconfirmation (from Cardello and Sawyer, 1992).

attributes differed from expectations, rated acceptability was lower than expected acceptability.

If we stop to consider the measure plotted on the ordinate in Figure 10.9, one can see that it is somewhat analogous to our definition of hedonic disconfirmation. The difference is that the post-test rating of acceptability actually incorporates the presumed effect of any hedonic disconfirmation experience. In other words, the construct of hedonic disconfirmation refers to the difference between the expected acceptability of the product and the intrinsic acceptability of the product prior to any influence by expectation effects. Such would be the case if we had prior baseline acceptability ratings for products for which we subsequently manipulated expectations. However, in the present circumstance, where the products were completely novel to the subjects, no such measure was possible. The post-test measure of acceptability already reflects any effects of sensory or hedonic expectations. Nevertheless, the measure plotted on the ordinate of Figure 10.9 is a pertinent measure to compare with direct ratings of the overall disconfirmation experience, since it may well be this judgment of acceptability that is compared cognitively to expected acceptability in order to arrive at an overall judgment of the degree to which the product matched or mismatched expectations. In point of fact, the correlation between this measure and the direct judgment of the

degree to which the product matched/mismatched expectations was found to be higher ($r = 0.65$; $p < 0.01$) than the correlation between sensory disconfirmation and the direct judgment of disconfirmation ($r = 0.47$; $p < 0.05$).

Both the inferred sensory measure of disconfirmation and subjects' direct judgments of disconfirmation were also found to be negatively correlated with product acceptance and with purchase intent. For both measures, greater disconfirmation resulted in lower acceptance and reduced purchase intent, supporting the general hypothesis that disconfirmed expectations result in negative affect and reductions in associated behavioral responses.

10.4.2 Direct manipulation of expectations

In the above experiment, expectations were not manipulated directly. Rather, the expectations were merely those that the individual brought to the testing situation. However, if the construct of expectations and our operational measures of it are to be of utility, they should respond to direct manipulations that commonly operate in real world situations. Moreover, by directly manipulating expectations, it should be possible to produce both positive and negative disconfirmation of sufficient range and magnitude to allow assessment of the effects in terms of the predictive models described in the previous section.

In a second set of experiments (Cardello and Sawyer, 1992) consumer expectations were directly manipulated through information presented about the product. The information was designed to manipulate both sensory and hedonic expectations and to produce both positive and negative hedonic disconfirmation. The test product was a commercial pomegranate juice that had been adjusted with distilled water and sucrose to yield a product having neutral hedonic tone, i.e. a consumer acceptance rating of approximately 5.0 and a bitterness intensity rating of approximately 3.0 ('slightly bitter' on a 7-point intensity scale). One hundred and eight consumers were divided randomly into four groups. In order to establish different levels of expectation (and disconfirmation), the groups were differentially exposed to positive, negative, accurate or minimal product information immediately prior to the test. They were instructed as follows:

All groups Today you will be testing a sample of juice from a new kind of tropical fruit . . .

Groups 1–3 The juice was nationally tested with a large group of consumers last December. Almost everyone who tasted it said they . . .

Group 1 (control group: accurate expectation – confirmed) 'neither liked nor disliked' it. It had an average score of 5.0 on a 9-point scale and had average bitterness.

Group 2 (low expectation – positive disconfirmation) 'disliked it very much'. It had an average score of 1.9 on a 9-point scale and was described as 'very bitter'.

Group 3 (high expectation – negative disconfirmation) 'liked it very much.' It had an average score of 8.1 on a 9-point scale and was described as 'not bitter at all'.

Group 4 (expectation/disconfirmation not manipulated). These subjects were told only that they would be tasting a new kind of juice. No other information was provided.

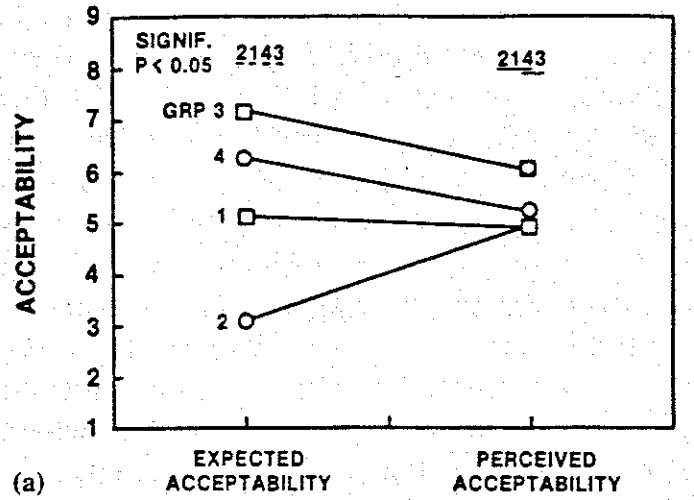
After exposure to the product information, subjects in each group generated an expected sensory profile of the juice by rating the intensity that they *expected* for the sweetness, bitterness, sourness, fruit flavor, and astringency of the juice. They also rated how much they *expected* to like/dislike the juice. A sample of juice was then served to each panelist, and they were asked to generate a perceived sensory profile of the product using the same sensory attributes as before. Judgments of acceptability were also obtained.

The relationships between mean ratings for expected and perceived acceptance, and for expected and perceived intensity of bitterness are shown in Figure 10.10(a) and (b). Mean ratings of expected acceptability were significantly different among the experimental groups (Figure 10.10a), as were the mean bitterness ratings (Figure 10.10b), with the exception of Groups 3 and 4.

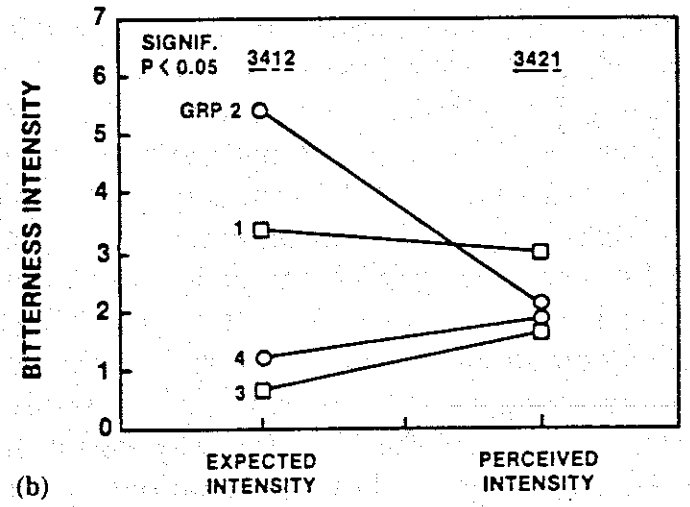
Since the test sample was formulated to have a pre-test acceptability of ~5.0, presentation of this sample to the various groups resulted in different levels of operationally defined confirmation/disconfirmation. For example, Group 3 had a mean expected acceptability of ~7.0, therefore, presentation of the test juice to this subject group would result in negative disconfirmation. Similarly, since Group 2 had a mean expected acceptability of ~3.0, positive disconfirmation would result in this group. In the control group (expected acceptability ~5.0), no disconfirmation would occur, while in Group 4 (expected acceptability ~6.3), a slight negative disconfirmation would occur.

The results of this study showed that the mean perceived acceptance rating in Group 3 was significantly higher than that for Group 1 (control), supporting an assimilation model effect for the high expectation–negative disconfirmation group. However, the mean ratings of perceived acceptability for both Groups 2 and 4 were not significantly different from the control, leading to the conclusion that positive disconfirmation and even intermediate levels of negative disconfirmation had no observable effect on overall ratings of acceptability.

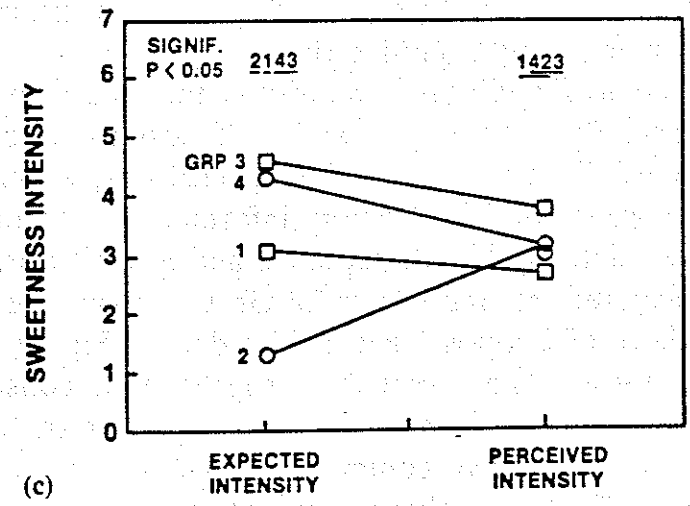
Examination of the sensory expectation data in Figure 10.10(b) reveals a still more interesting set of results. Although the sensory disconfirma-



(a)



(b)



(c)

Figure 10.10 Mean ratings for expected and perceived acceptance (a), and for expected and perceived intensity of bitterness (b), and sweetness (c) in a modified pomegranate juice. Data show assimilation effects for acceptability and sweetness in Group 3, assimilation effects for bitterness in Groups 3 and 4, and a contrast effect for bitterness in Group 2 (from Cardello and Sawyer, 1992).

tion that was established in Groups 3 and 4 (the juice tasted more bitter than expected), resulted in an assimilation effect, i.e. the perceived intensity ratings were significantly lower than for Group 1, the high bitterness intensity expectation (Group 2) resulted in a pronounced contrast effect, i.e. a significant lowering of the perceived intensity rating below that of Group 1. Of particular interest from a sensory standpoint are the data in Figure 10.10(c). Although expectations were not manipulated for 'sweetness', 'fruit flavor', 'astringency', or 'sourness' (all of which were rated for both expected and perceived intensity), strong associative effects were observed nevertheless for each of these attributes. (Note the significant differences in Figure 10.10(c) among the sweetness ratings for the groups in spite of the fact that nothing was communicated to the groups about the likely sweetness of the juice.) In addition, the high sweetness intensity expectation that was induced in Group 3 resulted in a significant assimilation effect on perceived sweetness (Figure 10.10(c), Group 3 versus Group 1). This effect was attributed to the strong positive association of sweetness intensity with hedonic response and/or negative association of sweetness intensity with bitterness intensity. When subjects expect juice to be well-liked and low in bitterness they also assume it will be sweet; whereas when they expect it to be low in acceptance and bitter, they also assume it will lack sweetness. It seems that expectations derived from information about one or more product characteristics can influence expectations for other characteristics of the product as well. Moreover, the expectations established in this way result in similar disconfirmation effects. Regardless of how 'expectations' are formed, they can be confirmed or disconfirmed, and the resultant effects on product perception follow the same cognitive rules.

Of some additional interest is the fact that the ratings of expected acceptability, bitterness, and sweetness for Group 4 are intermediate to those of Groups 1 and 3. These results were interpreted to mean that, in the absence of contradictory information, consumers expect fruit juice to have relatively high acceptance and low bitterness. As such, it would be anticipated that the effects for Group 4 would be parallel and intermediate to those of Groups 1 and 3. The data in Figure 10.10(a)–(c) support this conclusion. These data also suggest that consumers have expectations about the hedonic and sensory properties of foods/beverages, independent of any active communication of information about the product to them. Moreover, these expectations appear to have similar effects on subsequent perception and acceptability as those that are established by direct product information.

Although the acceptability data shown in Figure 10.10(a) support an assimilation model of the effect of disconfirmed expectations under conditions of high expectation/negative disconfirmation, the bitterness data in Figure 10.10(b) show both assimilation (Groups 3 and 4) and contrast

(Group 2) effects. As pointed out previously, the assimilation–contrast model predicts that assimilation will occur under conditions of low disconfirmation, and that contrast will occur when disconfirmation is large. It may be that the level of disconfirmation produced in Groups 3 and 4 fell within the limits in which an assimilation effect would occur, but that the disconfirmation in Group 2 was sufficiently large to produce a contrast effect.

Unfortunately, examination of the ratings of expected bitterness for Groups 3 and 4 versus Group 2 do not support the contention that greater disconfirmation was produced by the stimulus for Group 2. However, an important point needs to be made here. The levels of confirmation/disconfirmation established in the above experiment were dependent upon the use of a single test product presented to all subjects. The actual acceptability and bitterness of this product was indexed in pilot studies with a separate, random group of consumers. Thus, individual variation in sensory sensitivities and/or preferences toward the product characteristics would likely introduce variability into the levels of sensory and/or hedonic disconfirmation experienced by individual subjects. Such a 'group approach' to the stimulus problem makes it difficult to accurately index and compare slight differences in the levels of disconfirmation experienced by different groups of subjects. In order to reduce this variability, the test product presented to each subject would have to be pre-tested with that subject prior to the start of the experiment in order to establish its acceptability and perceived sensory characteristics for purposes of indexing the actual degree of disconfirmation relative to expectations.

10.4.3 Direct manipulation of disconfirmation levels

In order to gain better control over disconfirmation levels affecting individual subjects, pre-test measures of acceptability were obtained in an experiment utilizing cola beverages as test stimuli (Cardello and Sawyer, 1992). The products consisted of six national and local brands of cola beverage. In a baseline screening test, 281 subjects judged the acceptability of each of the six cola beverages. From these data, 180 subjects were selected in accordance with the experimental design shown in Table 10.2. The six different groups were established so that expectations for the beverage to be served were either high, intermediate, or low. This was accomplished by instructing subjects that they were to receive and evaluate a cola that was found by 'a national survey of cola drinkers' to be indistinguishable from a specific brand of cola that they knew and with which they were familiar. Thus, each individual expected the cola beverage to be indistinguishable from a brand in the preliminary test that he/she had either disliked (rated 1, 2, or 3; Groups 1 and 6); liked (rated

Table 10.2 Experimental design used for cola beverage study (from Cardello and Sawyer, 1992)

Group	Hedonic rating* in preliminary test		Level of expectation	Level of disconfirmation
	Brand expected	Brand tasted		
1	1, 2, 3	7, 8, 9,	Low	Large +
2	7, 8, 9	1, 2, 3	High	Large −
3	4, 5, 6	7, 8, 9	Intermediate	Intermediate +
4	4, 5, 6	1, 2, 3	Intermediate	Intermediate −
5	7, 8, 9	7, 8, 9	High	Low or none
6	1, 2, 3	1, 2, 3	Low	Low or none

*9-point hedonic scale: 1 = dislike extremely, 9 = like extremely.
Source: Cardello and Sawyer, 1992.

7, 8, or 9; Groups 2 and 5); or been neutral to (rated 4, 5, or 6; Groups 3 and 4).

To ensure the desired levels of confirmation/disconfirmation, the beverage presented to each subject was one that that individual had either liked (rated 7, 8, or 9; Groups 1, 3, and 5) or disliked (rated 1, 2, or 3; Groups 2, 4, and 6) in the preliminary test. Subjects in Groups 5 and 6 (confirmation groups) were given the same brand of cola that they had been led to expect.

Before tasting the test beverage, subjects rated expected acceptability. They were then served an unlabeled sample of cola in accordance with the experimental design layed out in Table 10.2. Subjects rated how much they actually liked/disliked the beverage and gave a direct rating of perceived disconfirmation, i.e. whether the cola tasted better, worse, or the same as expected.

Table 10.3 shows (1) the mean baseline pre-test acceptability ratings for the brands of cola that subjects were served, (2) subjects' mean ratings of the 'expected' acceptability of the test cola after being told the 'brand' to expect, and (3) the mean acceptability rating of the cola when presented as the 'new' cola. With the exception of Group 6, the manipulations were effective in establishing the desired levels of expectation/disconfirmation. In Group 6, the low expectation/low disconfirmation manipulation did not have its intended effect, i.e. it did not produce an expected acceptability similar to the baseline acceptability. The higher level of expected acceptability in this group caused it to serve as another intermediate negative disconfirmation condition.

All groups showed assimilation of acceptability ratings toward expected levels. That is, the mean rating of acceptability for the beverages in the high expectation groups were significantly higher than in the preliminary

Table 10.3 Results of the cola beverage study. The assimilation effects in each group are reflected in the statistically significant shifts in acceptability (post-test versus pre-test) toward the 'expected' acceptability

Group	Pre-test acceptability	Expected acceptability	Level of disconfirmation	Post-test acceptability rating	*t*-Values post-test versus pre-test acceptance
1	7.8	3.8	Large +	6.4	−4.33**
2	2.4	6.1	Large −	6.0	9.12**
3	7.8	5.3	Intermediate +	6.1	−6.24**
4	2.2	5.3	Intermediate −	5.5	9.83**
5	7.8	6.5	Low/no disconfirmation	7.4	−2.46*
6	2.2	5.2	[a]Intermediate −	5.6	9.20

9-point hedonic scale; 1 = dislike extremely, 9 = like extremely.
[a]Note that this experimental condition was intended to produce low/no disconfirmation, using a low baseline acceptability beverage (see text).
* $p < 0.05$; ** $p < 0.001$.
Source: Cardello and Sawyer, 1992.

test. Likewise, the mean ratings in the low expectation groups were significantly lower than in the preliminary test.

Figure 10.11 is a plot of the change in product rating for each subject as a function of the degree of disconfirmation he/she experienced, where disconfirmation was indexed by the algebraic difference in pre-test acceptability ratings for the expected and tasted brands. The strong positive association seen in Figure 10.11 reflects the fact that subjects who expected a worse product, rated the product lower than they had in the preliminary test, whereas subjects who expected a better product, rated it higher than in the preliminary test.

Under all conditions of positive and negative disconfirmation in this experiment, support was found for an assimilation model of disconfirmed expectations. Of course, the assimilation/contrast model predicts that contrast would occur only if the levels of disconfirmation are sufficiently high. However, cola beverages elicit a high degree of brand loyalty and preference. In the high positive and high negative disconfirmation conditions of this experiment subjects were told to expect their highest or lowest preference brands, but they were actually given the exact opposite. The resultant disconfirmation would be expected to be extremely high. However, no contrast effect was observed; only assimilation effects.

A Pearson product–moment correlation conducted between the inferred measure of disconfirmation i.e. rating of expected liking minus rating of perceived liking and direct ratings of disconfirmation, i.e. their response to the question 'Did the new cola taste as you had expected it to taste?' produced a high correlation coefficient ($r = 0.81$, $p < 0.001$). The

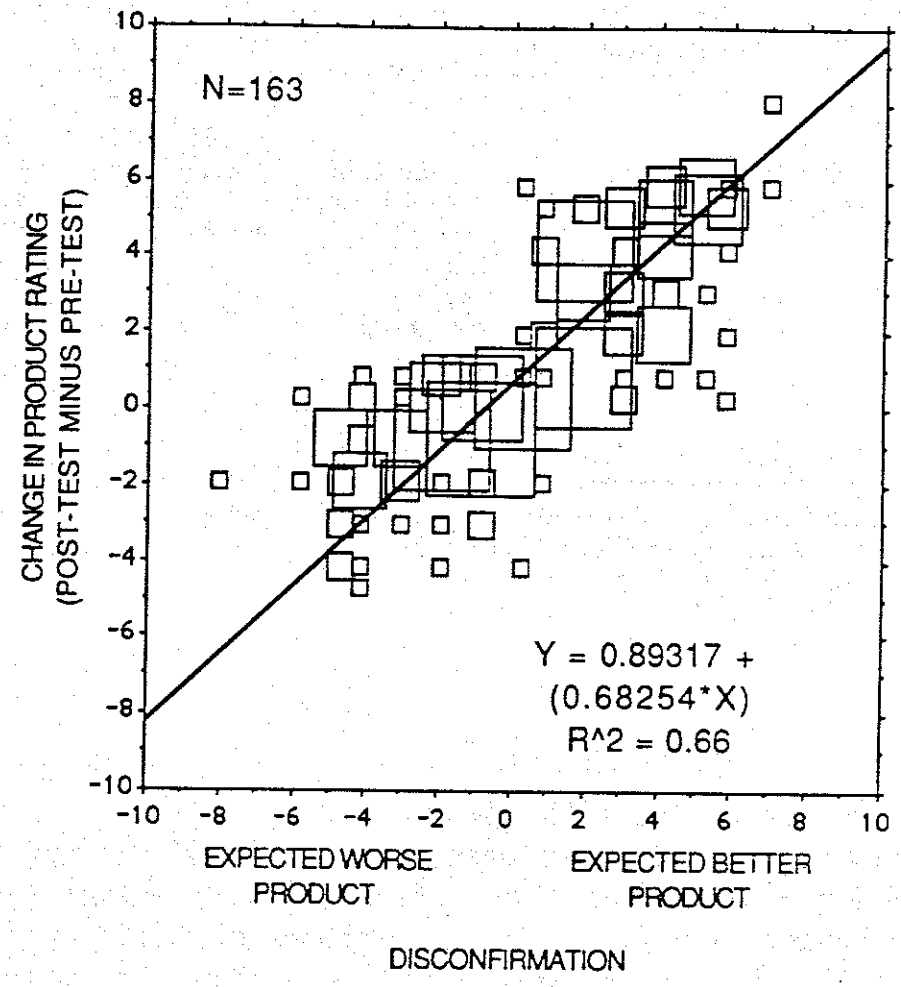


Figure 10.11 Linear regression plot of the change in acceptance rating (9-point hedonic scale) of cola beverages as a function of level of disconfirmation (from Cardello and Sawyer, 1992).

high correlation supports the notion that consumers' evaluation of the disconfirmation experience results from a comparison of perceived acceptability with expected acceptability.

With the exception of the one contrast effect that resulted from a high bitterness expectation, the results of the studies conducted to date lend support for an assimilation model of the effect of disconfirmed consumer expectations on product acceptance. The fact that the contrast effect occurred in only one of several high disconfirmation conditions across the several studies suggests that contrast effects may occur only rarely. This rarity of contrast effects is consistent with previous reports (Anderson, 1973; Olson and Dover, 1976). Further study is needed in order to identify the specific conditions that make contrast effects more likely, before any definitive model of disconfirmed expectations can be proposed.

10.5 Summary/conclusions

This chapter has put forth the hypothesis that disconfirmed consumer expectations play a significant role in both sensory perception of food and the determination of food acceptance. The evidence for this is drawn both from previously published data in the sensory and food acceptance literature that are amenable to such an interpretation, as well as from recent experiments that have been designed to examine specific aspects of the proposed effects. The chapter has also sought to review alternative models of the predicted effects of disconfirmed expectations and to suggest operational definitions and quantitative measures by which these theoretical constructs can be measured and the models tested using sensory research paradigms.

The empirical data collected to date have only touched the surface of this complex problem. Clearly, assimilation effects predominate, but contrast effects have also been observed. It is far too early to exclude any model from consideration. Much more needs to be done in order to understand the specific circumstances under which assimilation and contrast effects occur. Much more also needs to be done to understand the relationship between sensory disconfirmation and hedonic disconfirmation, and to determine if the effects observed on acceptance extend to other behavioral measures, e.g. choice, purchase and/or consumption.

The implications of the effects of disconfirmed consumer expectations are far-reaching. For strategic marketers and advertisers they raise the issue of the degree to which product expectations can be raised without risking severe failure if the product does not live up to those expectations. For those in institutional foodservice they raise serious questions about the best strategies for overcoming negative expectations about institutional food. Lastly, for the sensory scientist, these effects raise the issue of proper experimental methodology to control for the effects of subject's expectations about the food samples to be served. For all researchers involved in food acceptance and food behavior, the recognition, measurement and understanding of the role of consumer expectations should be of critical concern.

References

Allison, R.I. and Uhl, K. (1964) Influences of beer brand identification on taste perception. *J. Marketing Res.*, **1**, 36–9.

Anderson, R.E. (1973) Consumer dissatisfaction: The effect of disconfirmed expectancy on perceived product performance. *J. Marketing Res.*, **10**, 38–44.

Atkinson, J.W. (1954) Explorations using imaginative thought to assess the strength of human motives, in *Nebraska Symposium on Motivation*, Vol. 2, M.R. Jones (ed.), University of Nebraska Press, Lincoln, pp. 56–112.

Atkinson, J.W. (1957) Motivational determinants of risk-taking behavior. *Psychol. Rev.*, **64**, 359–72.

Atkinson, J.W. (1958) Toward experimental analysis of human motivation in terms of motives, expectancies, and incentives, in J.W. Atkinson edn., *Motives in Fantasy, Action, and Society*, Van Nostrand, Princeton, pp. 288–305.

Bartoshuk, L.M., Rennert, K., Rodin, J., and Stevens, J.C. (1982) Effects of temperature on the perceived sweetness of sucrose. *Physiol. and Behav.*, **28**, 905–10.

Bartoshuk, L.M. and Wolfe, J.M. (1990) Conditioned 'Taste' Aversions in Humans: Are They Olfactory Aversions? Paper presented at the meeting of the Association for Chemoreception Sciences, Sarasota, FL. April, 1990.

Bernstein, I.L. and Webster, M.M. (1980) Learned taste aversions in humans. *Physiol. and Behav.*, **25**, 363–6.

Birch, L.L., McPhee, L., Steinberg, L., and Sullivan, S. (1990) Conditioned flavor preferences in young children. *Physiol. and Behav.*, **47**, 501–5.

Birch, L.L., McPhee, L., Pirok and Steinberg, L. (1987) What kind of exposure reduces children's food neophobia? *Appetite*, **9**, 171–8.

Blank, D.M. and Mattes, R.D. (1990) Exploration of the sensory charateristics of craved and aversive foods. *J. Sens. Stud.*, **5**(3), 193–202.

Booth, D.A. (1972) Conditioned satiety in the rat. *J. Comp. Physiol. Psychol.*, **81**, 457–71.

Booth, D.A. (1981) The physiology of appetite. *Br. Med. Bull.*, **37**, 135–40.

Booth, D.A., Mather, P., and Fuller, J. (1982) Starch content of ordinary foods associatively conditions human appetite and satiation, indexed by intake and eating pleasantness of starch–paired flavors. *Appetite*, **3**, 163–84.

Bourne, M.C. (1982) *Food Texture and Viscosity: Concept and Measurement*. Academic Press, New York.

Breslin, P.A.S., Davidson, T.L., and Grill, H.J. (1990) Conditioned reversal of reactions to normally avoided tastes. *Physiol. and Behav.*, **47**, 535–8.

Calvino, A.M. (1986) Perception of sweetness: the effects of concentration and temperature. *Physiol. and Behav.*, **36**, 1021–8.

Capretta, P.J. and Rawls, L.H. (1974) Establishment of a flavor preference in rats: Importance of nursing and weaning experience. *J. Comp. and Physiol. Psychol.*, **86**, 670.

Cardello, A.V. and Maller, O. (1982) Acceptability of water, selected beverages and foods as a function of serving temperature. *J. Food Sci.*, **47**(5), 1549–52.

Cardello, A.V., Maller, O., Kapsalis, J.G., Segars, R.A., Sawyer, F.M., Murphy, C., and Moskowitz, H.R. (1982) Perception of texture by trained and consumer panelists. *J. Food Sci.*, **47**(4), 1186–97.

Cardello, A.V., Secrist, J., and Smith, J. (1983) Effects of soy particle size and color on the sensory properties of ground beef patties. *J. Food Qual.*, **6**, 139–51.

Cardello, A.V., Maller, O., Bloom-Masor, H., Dubose, C., and Edelman, B. (1985) Role of consumer expectancies in the acceptance of novel foods. *J. Food Sci.*, **50**, 1707–14, 1718.

Cardello, A.V. and Maller, O. (1987) Sensory texture analysis, an integrated approach to food engineering, in H.R. Moskowitz (ed.). *Food Texture: Instrumental and Sensory Measurement*, Marcel Dekker, Inc., New York, 177–215.

Cardello, A.V. and Segars, R.A. (1989) Effects of sample size and prior mastication on texture judgements. *J. Sens. Stud.*, **4**, 1–18.

Cardello, A.V., Sawyer, F.M., Kalick, J., and Lesher, L. (1991) Cognitive factors controlling food acceptance. Presented at 8th World Congress of Food Science and Technology, Toronto, Canada, September 29–October 4, 1991.

Cardello, A.V. and Sawyer, F.M. (1992) The effects of disconfirmed consumer expectations on food acceptance. *J. Sensory Stud.*, **7**, 253–77.

Carlsmith, J.M. and Aronson, E. (1963) Some hedonic consequences of the confirmation and disconfirmation of expectancies. *J. Abnorm. Soc. Psychol.*, **66**(2), 161.

Christensen, C.M. (1983) Effects of color on aroma, flavor and texture judgements on food. *J. Food Sci.*, **48**, 787–90.

Crook, C.K. (1978) Taste perception in the newborn infant. *Infant Behav. Dev.*, **1**, 52–69.

Davis, L.B. and Porter, R.H. (1991) Persistent effects of early odor exposure on human neonates. *Chem. Sens.*, **16**(2), 169–74.

Dawes, R.M., Singer, D., and Lemons, F. (1972) An experimental analysis of the contrast effect and its implications for intergroup communication and the indirect assessment of attitude. *J. of Personality and Social Psych.*, **21**(3), 281–95.
Desor, J.A., Maller, O., and Turner, R.E. (1973) Taste in acceptance of sugars by human infants. *J. Comp. Physiol. Psychol.*, **84**, 496–501.
Desor, J.A., Maller, O., and andrews, K. (1975) Ingestive responses of human newborns to salts sour and bitter stimuli. *J. Comp. Physiol. Psychol.*, **84**, 966–70.
Domjan, M. (1976) Determinants of the enhancement of flavored-water intake by prior exposure. *J. Exp. Psychol.*, **2**(1), 17.
Dubose, C.N., Cardello, A.V., and Maller, O. (1980) Effects of colorants and flavorants on identification, perceived flavor intensity, and hedonic quality of fruit-flavored beverages and cake. *J. Food Sci.*, **45**, 1393–9, 1415.
Dubose, C.N., Cardello, A.V., and Maller, O. (1981) Factors affecting the acceptability of low-nitrite smoked, cured ham. *J. Food Sci.*, **46**(2), 461–3.
Dunker, K. (1939) The influence of past experience upon perceptual properties. *Am. J. Psychol.*, **52**, 255.
Fanselow, M. and Birk, J. (1982) Flavor–flavor associations induce hedonic shifts in taste preference. *Animal Learn. and Behav.*, **10**, 233–8.
Feather, N.T. (ed.) (1982) *Expectations and Actions: Expectancy-Value Models in Psychology*, Lawrence Erlbaum Associates, Hillsdale, New Jersey.
Festinger, L. (1957) *A Theory Of Cognitive Dissonance*, Row & Peterson, Evanston, IL.
Gacula, Jr., M.C., Rutenbeck, S.K., Campbell, J.F., Giovanni, M.E., Gardze, C.A., and Washam II, R.W. (1986) Some sources of bias in consumer testing. *J. Sens. Stud.*, **1**, 175–82.
Garb, J.L. and Stunkard, A. (1974) Taste aversions in man. *Am. J. Psychiat.*, **131**, 1204–7.
Garcia, J., Ervin, F.R., and Koelling, R.A. (1966) Learning with prolonged delay of reinforcement. *Psychon. Sci.*, **5**, 121–2.
Garcia, J. and Koelling, R.A. (1966) Relation of cue to consequence in avoidance learning. *Psychon. Sci.*, **4**, 123–4.
Green, B.G. and Frankmann, S.P. (1987) The effect of cooling the tongue on the perceived intensity of taste. *Chem. Sens.*, **12**, 609–19.
Hall, R.L. (1958) Flavor study approaches at McCormick and Company, Inc., in *Flavor Research and Food Acceptance*, Reinhold, New York.
Helson, H. (1964) *Adaptation-level theory*, Harper and Row, New York.
Hendrix, J., Baldwin, R., Rhodes, V.J., Stringer, W.C., and Nauman, H.D. (1963) Consumer acceptance of pork chops. *Missouri Univ. Agr. Expt. Sta. Res. Bull.* no. 834.
Holman, E. (1975) Immediate and delayed reinforcers for flavor preferences in rats. *Learning and Motiv.*, **6**, 91–100.
Hovland, C.I., Harvey, O.J., and Sherif, M. (1957) Assimilation and contrast effects in reactions to communication and attitude change. *J. Abn. Soc. Psychol.*, **55**, 244–52.
Hutchings, J.B. (1977) The importance of visual appearance of food to the food processor and the consumer. *J. Food Qual.*, **1**, 267–78.
Insko, C.A. (1967) *Theories of Attitude Change*, Appleton-Century-Crofts, New York.
Jerome, N.W. (1975) Flavor preferences and food patterns of selected U.S. and Caribbean blacks. *Food Technol.*, **29**(6), 46.
Johnson, J.L., Dzendolet, E., and Clydesdale, F.M. (1983) Psychophysical relationships between sweetness and redness in strawberry flavored drinks. *J. Food Protect.*, **46**, 21–5.
Johnson, J.L. and Vickers, Z.M. (1988) Avoiding the centering bias or range effect when determining an optimum level of sweetness in lemonade. *J. Sens. Stud.*, **2**, 283–92.
Kalick, J. and Cardello, A.V. (1991) Consumer-oriented package designs: Improving military ration acceptance. Paper presented at Meeting of the Institute of Food Technologists, Dallas, TX, 1–5 June, 1991.
Kanig, J.L. (1955) Mental impact of colors in foods studied. *Food Field Reporter*, **23**, 57.
Kostyla, A.S. and Clydesdale, F.M. (1978) The psychophysical relationship between color and flavor of some fruit-flavored beverages – Influence of the addition of red. Unpublished manuscript.
Kramer, F.M., Edinberg, J., Luther, S., and Engell, D. (1989) The impact of food packaging on food consumption and palatability. Paper presented at Association for Advance-

ment of Behavior Therapy, Washington DC, November, 1989.
Kroeze, J.H. (1982) The influence of relative frequencies of pure and mixed stimuli on mixture suppression in taste. *Percept. and Psychophys.*, **31**(3), 276–8.
Larson-Powers, N. and Pangborn, R.M. (1978) Paired comparison and time intensity measurements of the sensory properties of beverages and gelatins containing sucrose or synthetic sweetners. *J. Food Sci.*, **43**, 41–6.
Latour, S.A. and Peat, S.A. (1979) Conceptual and methodological issues in consumer satisfaction research. in W.L. Wilkie (ed.) *Advances in Consumer Research*, Association for Consumer Research, **6**, 431–7.
Lawless, H. (1983) Contextual effect in category ratings. *J. Test. and Eval.*, **11**, 346–9.
Lawless, H.T. (1989) Exploration of fragrance categories and ambiguous odors using multidimensional scaling and cluster analysis. *Chem. Sens.*, **14**, 349–60.
Lawless, H.T., Glatter, S., and Hohn, C. (1991) Context-dependent changes in the perception of odor quality. *Chem. Sens.*, **16**, 349–60.
Lester, L.S. and Kramer, F.M. (1991) The effects of heating on food acceptability and consumption. *J. Foodservice Systems*, **6**, 69–87.
Lipsitt, L.P. (1977) Taste in human neonates: Its effect on working and heart rate in J.M., Weiffenbach, (ed.), *Taste and Development: The Genesis of Sweet Preference*, US Government Printing Office, Washington DC, pp. 124–42.
Logue, A.W., Ophir, I., and Strauss, K.E. (1981) The acquisition of taste aversions in humans. *Behav. Research and Therapy*, **19**, 319–33.
MacCorquodale, K. and Meehl, P.E. (1953) Preliminary suggestions as to a formalization of expectancy theory. *Psychol. Rev.*, **60**, 55–63.
MacCorquodale, K., Meehl, P.E., and Tolman, E.C. (1954) in W.K. Estes, S. Koch, K. MacCorquodale, P.E. Meehl, C. Muller, W. Schoenfeld and W.S. Verplanck, (eds), *Modern Learning Theory*, Appleton-Century-Crofts, New York, pp. 177–266.
Maga, J.A. (1973) Influence of freshness and color on potato chip sensory preference. *J. Food Sci.*, **38**, 1251.
Maga, J.A. (1974) Influence of color on taste thresholds. *Chem. Sens. and Flav.*, **1**, 115.
Maller, O., Cardello, A.V., Sweeney, J., and Shapiro, D. (1982) Psychophysical and cognitive correlates of discretionary usage of table salt and sugar by humans. in J.E. Steiner and J.R. Granchrow (eds.), *Proceedings of the Fifth European Chemoreception Research Organization Symposium*, IRL Press, London, pp 205–18.
Marks, L.E., Szczesiul, R., and Ohlett, P. (1986) On the cross-modal perception of intensity. *J. Exp. Psychol. Hum. Percept. Perform.*, **12**, 517–34.
Marks, L.E. (1988) Magnitude estimation and sensory matching. *Percept. Psychophys.*, **43**, 511–25.
Marks, L.E. and Warner, E. (1991) The slippery context effect and critical bands. *J. Exp. Psychol. Hum. Percept. Perform.*, 986–6.
McBride, R.L. (1982) Range bias in sensory evaluation. *J. Food Technol.*, **17**, 405–10.
McBride, R.L. (1985) Stimulus range influences intensity and hedonic ratings of flavor. *Appetite*, **6**, 125–31.
McBurney, D.H., Collins, V.B., and Glantz, L.H. (1973) Temperature dependence of human taste responses. *Physiol. and Behav.*, **11**, 89–94.
Meehl, P.E. and MacCorquodale, K. (1951) Some methodological comments concerning expectancy theory. *Psychol. Rev.*, **58**, 230–3.
Moir, H.C. (1936) Some observations on the appreciation of flavour in foodstuffs. *Chem. Ind.*, **55**, 145.
Moskowitz, H.R. (1973) Effects of solution temperature on taste intensity in humans. *Physiol. and Behav.*, **10**, 289–92.
Moskowitz, H.R., Kluter, R.A., Westerling, J., and Jacobs, H.L. (1974) Sugar sweetness and pleasantness, evidence for different psychological laws. *Science*, **184**, 583–5.
Nisbett, R. and Gurwitz, S. (1970) Weight, sex, and the eating behavior of human newborns. *J. Comp. Physiol. Psychol.*, **73**, 245–53.
Okabe, M. (1979) Texture measurement of cooked rice and its relationship to the eating quality. *J. Texture Stud.*, **10**, 131–52.
Oliver, R.L. (1977a) Effect of expectation and disconfirmation on postexposure product evaluations: an alternative interpretation. *J. Appl. Psychol.*, **62**(4), 480–6.

Oliver, R.L. (1977b) A theoretical reinterpretation of expectation and disconfirmation effects on postexposure product evaluations: experience in the field, in R.L. Day, (ed.), *Consumer Satisfaction, Dissatisfaction and Complaining Behavior* Papers from Marketing Research Symposium, School of Business, Indiana Univ., Bloomington, April 20–22, pp. 2–9.

Oliver, R.L. (1980) Theoretical bases of consumer satisfaction research: review, critique, and future direction, in C.W. Lamb, Jr. and P.M. Dunne, (eds), *Theoretical Developments in Marketing* American Marketing Association, Chicago, pp. 206–10.

Oliver, R.L. and DeSarbo, W.S. (1988) Response determinants in satisfaction judgments. *J. Consum. Res.*, **14**, 495–507.

Olshavsky, R.W. and Miller, J.A. (1972) Consumer expectation, product performance, and perceived product quality. *J. Mark. Res.*, **9**, 19–21.

Olson, J.C. and Dover, P. (1976) Effects of expectation creation and disconfirmation on belief elements of cognitive structure, in B.B. Anderson, (ed.) *Advances in Consumer Research* Association for Consumer Research 3, pp. 168–175.

Olson, J.C. and Dover, P. (1979) Disconfirmation of consumer expectations through product trial. *J. Appl. Psychol.*, **64**, 179–89.

Pangborn, R.M. (1960) Influence of color on the discrimination of sweetness. *Amer. J. Psychol.*, **73**(2), 229.

Pangborn, R.M., Chrisp, R.B., and Bertolero, L.L. (1970) Gustatory, salivary, and oral thermal responses to solutions of sodium chloride at four temperatures. *Percept. Psychophys.*, **10**, 289–92.

Parducci, A. (1965) Category judgement: A range frequency model. *Psychol. Rev.*, **72**, 407–18.

Pelchat, M.L. and Rozin, P. (1982) The special role of nausea in the acquisition of food dislikes by humans. *Appetite*, **3**, 341–51.

Peryam, D. and Pilgrim, F. (1957) Hedonic scale method of measuring food preferences. *Food Technol.*, **11**, 9.

Poulton, E.C. (1968) The new psychophys: six models for magnitude estimation. *Psychol. Bull.*, **69**, 1–19.

Pronko, N.H. and Bowles, J.W. (1949) Identification of cola beverages III: a final study. *J. Appl. Psychol.*, **33**, 605–8.

Rankin, K.M. and Marks, L.E. (1991) Differential context effects in taste perception. *Chem. Sens.*, **16**, 617–29.

Riskey, D.R., Parducci, A., and Beauchamp, G.K. (1979) Effects of context in judgements of sweetness and pleasantness. *Percept. and Psychophys.*, **26**, 171–6.

Riskey, D.R. (1982) Effects of context and interstimulus procedures in judgements of saltiness and pleasantness. *Selected Sensory Methods: Problems and Approaches to Measuring Hedonics*. ASTM STP 773, J.T. Kuznicki, Am. Soc. Testing and Materials, 71–83.

Rosenstein, D. and Oster, H. (1988) Differential facial responses to four tastes in newborns. *Child Dev.*, **59**, 1555–68.

Roth, H.A., Radle, L., Gifford, S.R., and Clydesdale, F.M. (1988) Psychophysical relationships between perceived sweetness and color in lemon and lime flavored beverages. *J. Food Sci.*, **53**, 1116–9.

Rotter, J.B. (1955) The role of the psychological situation in determining the direction of human behavior, in *Nebraska Symposium on Motivation* (M.R. Jones ed.), University of Nebraska Press, Lincoln, pp. 245–69.

Sawyer, F.M., Cardello, A.V., Prell, P.A., Johnson E.A., Segars, R.A., Maller, O., and Kapsalis, J. (1984) Sensory and instrumental evaluation of snapper and rockfish species. *J. Food Sci.*, **49**, 727.

Sawyer, F.M., Cardello, A.V., and Prell, P.A. (1988) Consumer evaluation of the sensory properties of fish. *J. Food Sci.*, **53**(1), 12–18, 24.

Schutz, H.G. (1954) Color in relation to food preference, in K.T. Farrell, J.R. Wagner, M.S. Peterson, and G.M. McKinnery (ed.). *Color in Foods: A Symposium*, p. 21.

Schutz, H.G., Damrell, J.D., and Locke, B.H. (1972) Predicting hedonic ratings of raw carrot texture in sensory analysis. *J. Texture Stud.*, **3**, 227–32.

Schutz, H.G. (1988) Beyond preference: appropriateness as a measure of contextual accept-

ance of food, in *Food Acceptability* (D.M.H. Thomson ed.), Elsevier Applied Science, London, 115–34.

Sheen, M.R. and Drayton, J.L. (1988) Influences of brand label on sensory perception, in *Food Acceptability* (D.M.H. Thomson ed.), Elsevier Applied Science, London, 89–99.

Sherif, M. and Hovland, C.I. (1961) *Social Judgement: Assimilation and Contrast Effects in Communication and Attitude Change*, Yale University Press, New Haven.

SIK Information (English) (1976) The taste of decolored foods. **5**(1), 6. From Marit Neymark (1975) Sa fargas var smak. In Rad och Ron. **10**. 16.

Steiner, J.E. (1979) Human facial expressions in response to taste and smell stimulation, in H.W. Reese and L.P. Lipsett, (eds), Vol 13 *Adv. Child Dev.* Academic Press, New York, 257–95.

Stevens, S.S. (1957) On the psychophysical law. *Psych. Rev.*, **64**, 154–81.

Stone, H., Oliver, S., and Kloehn, J. (1969) Temperature and pH effects on the relative sweetness of suprathresholds mixtures of dextrose and fructose. *Percept. Psychophys.*, **5**, 257–60.

Szczesniak, A.S. (1971) Consumer awareness of texture and of other food attributes. II. *J. Text. Stud.*, **2**, 196–206.

Szczesniak, A.S. (1972) Consumer awareness of and attitudes to food texture. II: Children and teenagers. *J. Texture Stud.*, **3**, 206–217.

Szczesniak, A.S. (1991) Textural perceptions and food quality. *J. Food Quality*, **14**(1), 75–86.

Szczesniak, A.S. and Kahn, E.L. (1963) Consumer awareness of texture and other food attributes. *Food Technol.*, **17**, 74–7.

Szczesniak, A.S. and Kahn, E.L. (1971) Consumer awareness of and attitudes to food texture. I: Adults. *J. Texture Stud.*, **2**, 280–95.

Tolman, E.C. (1938) The determiners of behaviors at a choice point. *Psychol. Rev.*, **45**, 1–41.

Tolman, E.C. (1951) *Behavior and Psychological Man*. University of California Press, Berkeley.

Tordoff, M.G., Tepper, B.J., and Friedman, M.I. (1987) Food flavor preferences produced by drinking glucose and oil in normal and diabetic rats: evidence for conditioning based on fuel oxidation. *Physiol. and Behav.*, **41**, 481–7.

Torrance, E.P. (1958) Sensitization versus adaption in preparation for emergencies: Prior experience with an emergency ration and its acceptability in a stimulated survival situation. *J. Appl. Psychol.*, **42**, 63.

Tuorila-Ollikainen, M., Mahlamali-Kuttanen, S., and Kurkela, R. (1984) Relative importance of color, fruity flavor, and sweetness in the overall liking of soft drinks. *J. Food Sci.*, **49**, 1598–600.

Urbanzi, G. (1982) Investigation into the interaction of different properties in the course of sensory evalution. I. The effect of colour upon the evaluation of taste in fruit and vegetable products. *Acta. Alimentaria*. **11**, 233–43.

Vickers, Z.M. (1982) Relationships of chewing sounds to judgements of crispness, crunchiness, and hardness. *J. Food Sci.*, **47**(1), 121–4.

Vickers, Z.M. (1991) Sound perceptions and food quality. *J. Food Qual.*, **14**(1), 87–96.

Wheatley, J. (1973) Putting color into marketing. *Marketing*, **67**, 26–9.

Worthington, O.J. (1960) The correlation of color measurements on canned plums with consumer acceptability. *Food Tech.*, **15**(6), 283–5.

Yoshikawa, S., Nishimaru, S., Tashiro, T., and Yoshida, M. (1970a) Collection and classification of words for description of food texture. I. Collection of words. *J. Texture Stud.*, **1**, 437–442.

Yoshikawa, S., Nishimaru, S., Tashiro, T., and Yoshida, M. (1970b) Collection and classification of words for description of food texture. II. Texture profiles. *J. Texture Stud.*, **1**, 443–51.

Yoshikawa, S., Nishimaru, S., Tashiro, T., and Yoshida, M. (1970c) Collection and classification of words for description of food texture. III. Classification of multivariate analysis. *J. Texture Stud.*, **1**, 452–63.

Zellner, D.A., Bartoli, A.M., and Eckard, R. (1991) Influence of color on odor identification and liking ratings. *Amer. J. Psych.*, **104**(4), 547–61.

Zellner, D.A., Stewart, W.F., Rozin, P., and Brown J.M. (1988) Effect of temperature and expectations on liking for beverages. *Physiol. and Behav.*, **44**, 61–8.

Zellner, D.A., Rozin, P., Aron, M., and Kulish, C. (1983) Conditioned enhancement of human's liking for flavors by pairing with sweetness. *Learning and Motiv.*, **14**, 338–50.